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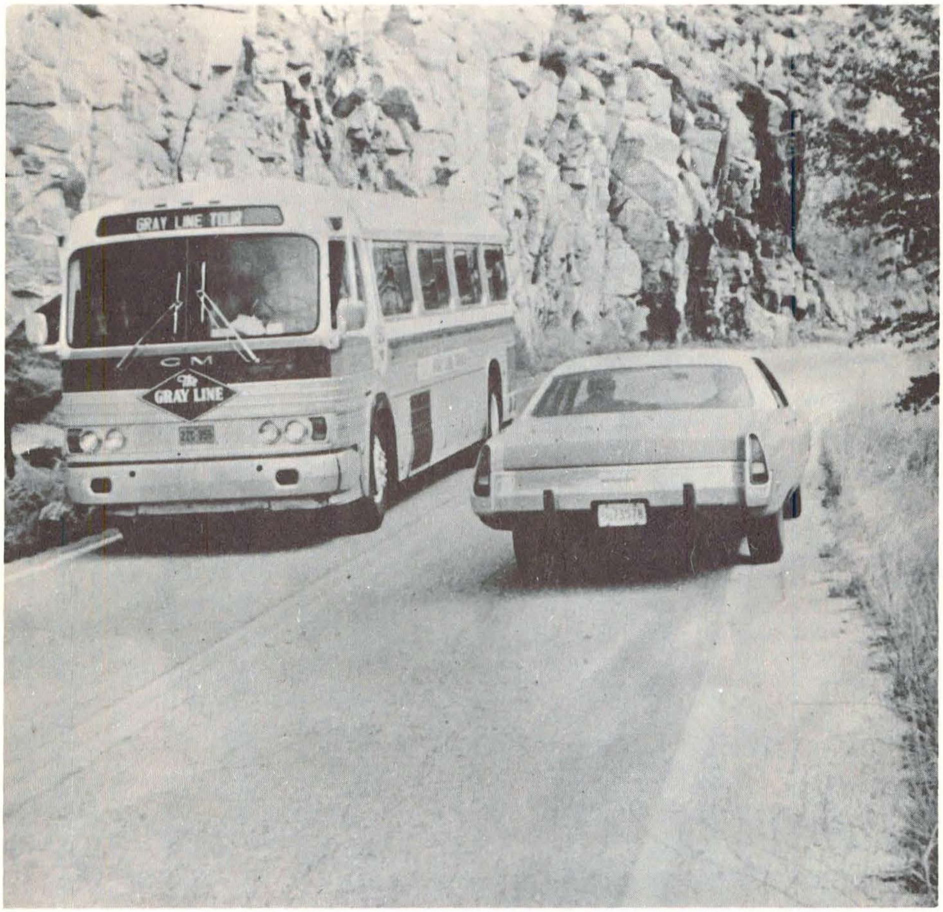
TECHNOLOGICAL AND ENVIRONMENTAL PLANNING CONSIDERATION TO MINIMIZE THE ENVIRONMENTAL IMPACT OF TRANSPORTING PEOPLE AND PRODUCTS THROUGH WILDLAND AREAS AN OVERVIEW



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TECHNOLOGICAL AND ENVIRONMENTAL PLANNING CONSIDERATIONS TO MINIMIZE THE ENVIRONMENTAL IMPACT OF TRANSPORTING PEOPLE AND PRODUCTS THROUGH WILDLAND AREAS AN OVERVIEW

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In Cooperation with the
Eisenhower Consortium for Western
Environmental Forestry Studies

Rocky Mountain Forest and Range
Experiment Station
U. S. Forest Service
Fort Collins, Colorado

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March 12, 1976

Dr. Ross Carder
Research Engineer
Rocky Mountain Forest and
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Forestry Sciences Laboratory
CU Box 4106, NAU
Flagstaff, Arizona 86001

Dear Dr. Carder:

We are pleased to transmit herein the final copy of the report prepared in compliance with the provisions of Eisenhower Consortium Study EC-119 (16-455-CA), Movement of People from Urban to Wildland Areas. This report incorporates all of the revisions which were made in conjunction with your review of the manuscript and subsequent visit to our campus on February 10, 1976.

It was a pleasure working with you and all of the Forest Service people who cooperated on this study. We look forward to moving ahead on the next phase of the project.

Thank you for your interest and cooperation.

Sincerely,

James D. Mertes

James D. Mertes, Associate Professor

Charles L. Burford

Charles L. Burford, Associate Professor

Investigators

tw

Enclosure

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The study represents an interdisciplinary effort between the Department of Park Administration, Landscape Architecture and Horticulture and the Department of Industrial Engineering at Texas Tech University. Preparation of this report represents a major portion of the graduate work of the junior author.

The investigators were assisted by a host of cooperative individuals who deserve mention and special note of appreciation. Special recognition is given to:

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General Superintendent
Mesa Verde National Park

Mr. Amos Cordova, Station Agent
Denver and Rio Grande Western Railroad
Durango, Colorado

Mr. Bill Winkler, President
Mesa Verde Park Company
Mancos, Colorado

Substantial information was provided by a number of governmental agencies and private companies involved in transportation research and planning. This enormous response was indeed gratifying.

The Project Coordinator for the Forest Service was Dr. Ross Carder, Research Engineer, with the Flagstaff work unit. Dr. Carder joined the investigators for one field trip and provided considerable input to the final manuscript.

The investigators wish to express their appreciation to Mrs. Patricia Austin, Mrs. Anne Seitz, and Mrs. Terry Wilson in the preparation of the final report.

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Summary of the Findings

The Principal findings of this study are:

1. That the interest in transportation planning for the development of workable solutions to the problem of minimizing the environmental impact of moving large numbers of people through wildland areas appears widespread among federal and state land managing agencies.

2. That the development of transportation technology and hardware for mass conveyance systems is extensive and involves many of the large diversified aerospace firms such as Ling-Tempco Vought, Boeing Aircraft, General Dynamics, and Lockheed Aircraft.

3. That much of the transportation planning and hardware development which has come out of the search for solutions to urban traffic problems is not easily adaptable to the unique problems and situations encountered in wildland resource areas without substantial modification.

4. That to be effective most mass conveyance systems require high volumes of riders traveling along routes where key facilities are clustered, and where competing modes are either restricted or eliminated.

5. That wildland recreational area transportation requirements may fluctuate seasonally while most alternatives to the private automobile in typical situations require stable year round volumes to be economically justifiable, or else very high profit.

6. That existing wildland road networks (links) have been developed at a considerable economic and environmental cost. This makes those alternatives that can operate on existing links more attractive than those requiring special right of ways.

7. That there appears to be a decrease in some of the user's clamor for more roads throughout the national forests. Attempts to construct highways through national forests in recent years have met bitter citizen resistance often culminating in lengthy litigation.

8. That the most heavily used recreational sites are the most appropriate areas to consider the switch to total or limited reliance on mass conveyance.

9. That the more exotic forms of mass conveyance, such as tramways, automated people movers, and similar systems, while creating minimal environmental impact, are very expensive to install and operate. These are not considered feasible solutions in most instances.

10. That the forest circulation system, for the most part, must be a multiple use system capable of moving people and resources. Only in specific single purpose situations can an exclusively recreational conveyance system be considered.

11. That the circulation system is a major factor influencing land conversion and management on both public and private land. In a few areas there now appears to be a move to integrate forest transportation planning with local and regional comprehensive planning. (See the Sabino Canyon Recreation Area Case Study).

12. That recreational attractions do not exist in and of themselves. They must be identified, designed, and developed to the extent suitable for a specific purpose, and managed at some level. Access to such attractions is a part of this process. The circulation system plays a major role in the comprehensive resource management plan for a forest recreational area. The design and management of this system can be effectively used to allocate or ration visitation within high impact areas which are extremely fragile.

13. That more knowledge concerning the social and psychological factors involved in the shift from exclusive reliance on the private automobile to use of various forms of mass conveyance systems is needed by planners. Previous research dealing with characterizing recreationists and developing socioeconomic profiles of various user groups can be applied to this area of transportation planning.

14. That no data has been uncovered which leads us to determine that the end of mass reliance on the private automobile is imminent. Higher fuel costs and even limited availability have only slightly dampened the level of recreational travel in the United States. This does not mean, however, that there is not a very significant role for certain applications of mass conveyance technology to solve existing or prevent future problems of environmental degradation.

CHAPTER I

Introduction

Concern for the safe, efficient, and least environmentally damaging method of moving forest products and recreational users through a wildland area has been a concern of forest planners and managers for many years. The road systems in the first national forests and parks, which were constructed prior to the widespread availability of the private automobiles, were designed for stage coaches and later motor buses.

In the early days of rail passenger travel in the west, it became readily apparent to Park Service and railroad executives that service to the major parks was essential for both parties. Mather (1) had to promote visitation to the parks, in part to generate popular interest and political support for the fledging organization. On the other hand, the railroads wanted to promote passenger travel throughout the west as part of the move to develop strong transcontinental transportation routes. As a result of these two interests, rail connections and accompanying tourist facilities were constructed in many of the western parks. A good example of this is the large hotel and rail facility in Grand Canyon National Park. Many of these facilities could be used again if it becomes both feasible and fashionable to utilize rail travel as a form of public conveyance for recreational travel to national parks. In a July 30, 1974 letter from L. Fletcher Prouty, Director of Plans and Public Relations for the National Railroad Passenger Corporation, to Mr. Tom Jones (See Appendix C) Mr. Prouty observed, "The whole concept (recreational passenger service) is right and it is one of those things which rail travel has the potential to do better than any other." Prouty went on to explain that "with adequate funds to repair track and purchase new equipment the railroads could provide acceptable passenger service to many areas they once covered."

With the drastic increase in visitation to wildland recreation areas, which began in the early sixties and continues somewhat abated today, it became apparent to resource managers that better transportation planning was needed and that a search for ways to reduce the impact of the burgeoning numbers of automobiles which were filling wildland recreational areas was necessary. Urban planners recognized the necessity of initiating

work on various forms of mass conveyance system. Increasing concerns over levels of air and noise pollution as well as a greater public awareness of the many negative aesthetic aspects of highway construction resulted in the passage of a wide range of federal and state environmental legislation restricting and conditioning the use of many conventional forms of conveyance.

Warnings of shortages of fossil fuel reserves, higher exploration and production costs, excessive inefficiencies in the various types of conventional power units, and rapidly rising prices to consumers were sounded as early as the middle fifties. Too often, it appears that little attention is placed on research and development activities leading to the development of substitute products or systems until a crisis of considerable magnitude arises. The Arab oil embargo of 1973 and the subsequent actions of the OPEC cartel spurred the United States government to seek energy self-sufficiency for the country by the 1980's. These actions have led to several significant and sobering conclusions, often very difficult for Americans to come to grips with. Some of these are:

> The United States is heavily dependent upon foreign countries, many of whom are politically hostile and belligerent, for an increasing amount of petroleum and mineral resources.
>
> As underdeveloped countries expand their economic base and become more aware of their political power, they are less inclined to export cheap raw materials to the highly developed nations.
>
> The United States will continue to pay more for imported petroleum as well as that produced within its boundaries;
>
> The day of cheap travel, either by private automobile or public carrier is over. Americans will continue to spend more of their income for travel as well as all other forms of energy;
>
> Notwithstanding present federal air pollution regulations governing emission discharge from internal combustion engines, it is reasonable to assume that technology and public policy will continue on a course of mutually compatible developments which reflect higher levels of operational efficiency and environmental quality.
>
> The search will continue for alternative power units and sources of fuel to allow continued use of personal forms of conveyance at reasonable prices.

Pressure will continue for definitive national energy policies which will include allocation priorities for public and private transportation uses.

The tourism industry will continue to exert strong political pressure for fuel allocation and pricing policies which do not seriously hamper their business environment.

Already, the impact of the national environmental awareness and the energy picture has been observed within the recreation and tourism sector of the economy. Long distance travel has decreased in some areas of the country. Use of parks and recreation areas closer to urban areas has increased substantially over the past two years. Recreational trips are shorter and more carefully planned. Special package tours to recreation and tourism clusters are increasing in popularity with airlines, bus companies, and resort managers.

At the administrative level of the Park Service and Forest Service, there appears to be a more cautious position with respect to the continued development of highway systems. In some heavily used areas such as Yosemite National Park, partial conveyance systems have been initiated to lessen environmental stress and provide a higher quality visitor experience. Many of these new experiences in transportation planning and visitor conveyance are discussed in this report.

The National Forests are similar to the National Parks and other wildland recreation areas in many respects. The differences, however, present major, but certainly not insurmountable, challenges to forest land resource planners and managers.

Management of the National Forest involves a host of resource activities which include the harvesting and cultivation of renewable resources. Outdoor recreation and aesthetics are both products derived from the sustained yield management of forest resources. The forest transportation system is not similar to the normal park circulation system, simply responding to a single purpose type of use. National forests are not restricted access areas as are parks. Thus their road linkages are open rather than closed or limited systems. The conversion of these links to limited vehicle use is more difficult than in parks because of the range of vehicles required to transport the products of the forest to market.

National forests are extremely diverse resource areas. Many have

unique areas and aesthetic qualities that parallel or surpass some of those found in park reservations. Hence, they are extremely popular recreational areas and attract large numbers of visitors. Problems of crowding, traffic conjestion, noise, environmental stress, and declining quality of the recreational experience confront forest land managers in areas of heavy use. At one time the pressure was for more and larger road systems. Today it appears that recreational users of forest areas are beginning to press for solutions to transportation problems which are less violent in terms of their environmental impact, even though this may require modifications in travel mode and recreational life style.

The Problem

The Forest Service, like the Park Service and other managing agencies who have witnessed the burgeoning influx of private automobiles in recreational areas, has become more concerned with developing appropriate management strategies to deal with these problems. Rather than to continue to build more roads into heretofore inaccessible areas and enlarge existing roadways to accommodate more traffic generated by growing recreational developments such as the winter sports complexes, the Forest Service has begun to look for alternative solutions. In addition to problems associated with the tremendous number of private vehicles found within some forest areas a host of related problems are associated with the use of private automobiles as the principal mode of conveyance. These include:

* Visual blight that is often unavoidable even with the most careful location and construction of forest highways;

* Hydrologic imbalance resulting from disruption of natural drainage patterns;

* Eminent danger to forest wildlife particularly where a high volume artery bisects a major migration route;

* Noise and air pollution which detract from the quality of the recreational experience as well as impact on plant and animal life; and

* Forest sprawl of campgrounds and other recreational developments in areas where they are under-utilized and expensive to maintain.

Notwithstanding the Bureau of Outdoor Recreation's (2) finding that driving for pleasure represents one of the most popular forms of outdoor recreation, it has become quite obvious that recent developments in transportation planning suggest that in certain instances alternative modes have the potential of being more energy efficient, feasible, and gratifying than the private automobile. This study responds to that recognition.

Purpose of the Study

The purpose of this study was to identify, investigate, and evaluate the economic, environmental, and social implications of those technically feasible mass conveyance systems which could be utilized as a means of solving specific visitor conveyance problems at recreational developments in forest wildland areas.

Objectives

The objectives of the study were:

1. The identification and preliminary assessment of the probable environmental and socio-economic consequences of technically feasible modes of transportation systems which could be utilized in National Forest recreational areas.

2. Development of a conceptual framework for use by forest planners in devising appropriate solutions to visitor conveyance problems in high density recreational areas as well as throughout the forest management area.

3. Outline the appropriate research required to completely develop a transportation mode assessment procedure and a transportation system design and specification methodology.

CHAPTER II

Procedure

Several research procedures were employed in the preparation of this study. These were:

Comprehensive review of the literature in the field of transportation and closely allied fields;

Correspondence with engineers, manufacturers, and recognized experts in the field, including representatives of the transportation planning task forces operating within the Forest Service;

A problem idenfification and solution assessment meeting with the land use and recreation planning staff of the Forest Service Region 3 foresters' staff in Albuquerque, New Mexico;

On-site visits to several recreational areas where some form of mass conveyance system was either in operation or under consideration. These sites included:

1. Mesa Verde National Park, Colorado. Observation of the park circulation system and the concessionnaire mini-bus operation. This included a discussion of the concession contract, the financial records, and manufacturers' operational data on the vehicles.
2. Durango-Silverton Railroad, Colorado. Observation of the commercial passenger (tourist) narrow gauge railroad. This included a visit with the station agent concerning the operation and management of the railroad.
3. Tucson (Pima Country), Arizona. Meeting with the Forest Supervisor and planning staff of the Coronado National Forest and field study of the Sabino Canyon have been closed to private auto travel. A bus system operating between metropolitan Tucson and the recreational area has been proposed, but is not operational.

A project evaluation and brainstorming session with a technical advisory group composed of knowledgable individuals from the College of Engineering at Texas Tech University was held at this Lubbock facility.

The findings reported herein represent a synthesis of the information assembled from each of these sources and activities.

CHAPTER III

Literature Survey

Introduction to Wildland Transportation

The efficient movement of people into and within wildland areas is rapidly becoming a matter of great concern to the users and managers of these recreational resources. Most people now live in fairly close proximity to their income generating activities. It is paradoxical that to make a living a man has to live in a place removed from where he desires to spend his leisure time, but the majority of income producing jobs are centeralized in the metropolitan areas which are separated by time and distance from the less developed hinterlands. The work ethic is strong in American society, but because of shortened work hours, Americans have an increasing amount of leisure time to spend however they see fit. (3) Man appears to have a need to journey back to the less structured environments to recreate and commune with nature. The 4,796 million visits to outdoor recreation areas that were made by Americans in 1970 would seem to qualify the assumption that Americans either have a need or desire for outdoor recreation opportunities.

In his quest for escape from the urban areas, man has brought elements of the city with him to the wildlands. Urban conjestion and pollution in the form of traffic jams, exhaust fumes, massive asphalt parking lots, roadside litter, and noise are some of the trademarks of urban life that have contributed to degredation of the wildland areas. A pressing question facing resource planners and managers today is: How can greater balance in the wildland resource be achieved so as to minimize the impact of increasing demands for renewable products and recreational use? (5, 6)

Interrelationships between outdoor recreation and the quality of the environment have begun to be increasingly apparent. (3) The statutorily protected and intensely managed National Parks are considered by many citizens as the highest-quality recreation experience available. (4)

It has been suggested that the paramount problem affecting the environmental quality of wildland areas is not the people who use the areas,

but the private automobile associated with that use: "Ideally, everyone would park at the gate and proceed on foot to the staggeringly beautiful geysers, emerald and sapphire pools, . . . rocky crags, meadows, mountains, lakes, falls and forest." (7, 8) The problem has been that people have not parked their automobile at the gates; use of the private vehicle for transportation to and within re-reational areas has been accepted as an essential element for full use and enjoyment of these areas.

National Scale of Transportation

According to statistics, private transportation plays a large role in American society. For the approximately 206 million people in the United States in 1971 there were 118 million vehicles, 96 million of which were automobiles. (9, 10) Automobile passenger miles (including motorcycle) for 1971 has been estimated at 2,089,582 million miles, or slightly over 10,000 miles per capita mobility, Americans spend one fifth of their Gross National Product on transportation, close to $200 billion per year. (11) These staggering figures indicate the importance Americans place on private transportation, but they do not necessarily indicate the efficiency or quality of the existing transportation complex. The United States Department of Transportation (11) suggests that "The quality of transportation--how safety, effectively and efficiently it meets our needs--affects the quality of our lives."

These observations about the quality of our present transportation quality and efficiency take on greater magnitude because of the energy shortage encountered in the mid-seventies. When crude oil became more difficult to acquire in many parts of the United States in 1974 the high level of dependence on the private automobile as the principle mode of transportation became readily apparent. Philip Abelson (12) commented about the long lines of automobiles at service stations waiting for rationed fuel in February of 1974 "... they convey a message about the importance that many people attach to their automobiles." Abelson suggests that this attachment to automobile transportation is both economic and emotional on the part of the owner.

The fuel shortage yielded data about the safety, efficiency, and effectiveness of this economic and emotional attachment to the private

automobile, and to the role it plays in our transportation complex. Twenty percent fewer automobile related deaths were reported for 1974, compared with 1973, because of the fuel shortage. (13) This drop was partially due to fewer miles being driven, but the drop in fatalities from 4.3 to 3.5 per 100 million miles driven, indicates that other factors are involved. It is currently thought that the various efforts employed to increase the efficiency of the private autombile as a mode of transportation was a contributing factor in the increased safety associated with the fuel shortage. (13)

Efficiency of the private automobile as a converter of energy was also attacked during the fuel shortage. The automobile consumes almost 40 percent of the oil used in the United States, yet vehicle miles per gallon of gasoline is much lower than the technical potential because of accessories, emission control devices, and inefficiently designed circulation systems. (14) Lowered speed limits and the automakers shift to more fuel efficient vehicle production indicates that the inefficiency of automobile transportation has been noted. (15)

The effectiveness of automobile dominated transportation in the United States was also questioned by fuel conscious Americans. People living in suburbs who were commuting to work in private automobiles turned to car pooling and mass transit only to find them more effective than their cars in supplying basic transportation needs. (15)

Recreation and Transportation

Outdoor recreation, particularly that which takes place on state and federal controlled public lands, is dependant on transportation because the resource base is usually located some distance from the participants' residence. The National Recreation Access Study of 1975 (16) states that an estimated ninety to ninety-five percent of all person-trips to significant outdoor recreational areas were defined as those which have 100,000 or more visitors per year, and the majority of these were found to have poor to non-existant public transportation service. (16)

Others studies (2, 17) have indicated that driving for pleasure appears to be the most popular form of outdoor recreation, and that as much as 18 percent of all trips made in this country (accounting for 34 percent of all vehicle mileage) have social or recreational purposes.

Wildland transportation planning, like other types of transportation planning, must be based on information that characterizes the situation. (18) Presently, in the United States, the private automobile is the dominant transportation mode in terms of number of recreational trip-miles traveled. (10) Because of this, and the lack of alternative modes used for access to wildland areas, most recreation area circulation systems are designed to accommodate a wide range of motor vehicles. Several characterization have been identified that describe the general situation that has emerged from the evolution of the private automobile to its position as the primary transportation mode. The National Recreation Access Study of 1974 noted:

> -effective capacity of many recreational areas depends on the number of cars that will be stored because of the area's dependency on the automobile.
>
> -non-auto internal circulation systems have been successful in a very few areas but users are still dependent on the private automboile for access to the areas from their residence or other recreation areas.
>
> -a public transportation system that brings people to the areas without moving them through it would be unattractive because most recreation areas have internal circulation systems designed for private automobile use.
>
> -public attitudes, market conditions, and convenience factors have reduced public transportation's ability to successfully compete with the private automobile as a transportation mode for recreation access. (16)

United States Forest Service Transportation Planning

The United States Forest Service, as an example of a major governmental land managing agency, operates under the concept of multiple use. The Multiple Use-Sustained Yield Act of 1960, Title 15 United States Code, (Section 528-531), directs the Forest Service to manage the National Forests so as to produce timber, forage, water, wildlife and other outdoor recreation." The establishment of road networks within the National Forests to enable use, and protection of the resource fits within the scope of the

Organic Administration Act of 1897 Title 16, United States Code, (Section 475). A brief history of National Forest transportation planning is found in Part 1 of Transportation System Planning for Forest Resource Management: Introduction to the Transportation System Planning Project (19) published by the United States Forest Service as a Technical Report. A sysnopsis of this report is presented here because of its importance in outlining the history of wildland transportation planning.

Initially, trails were the only means of access to the Forest Reserves established in the 1890's. These trails gradually gave way to roads, often located along the same route, that would accommodate wheeled vehicles for fire protection activities. In the mid-thirties many roads were built in the National Forests by the Civilian Conservation Corps to facilitate a wide range of activities. The mid-fifties gave rise to roads planned, and identified in terms of their primary use for specific functions, such as timber management. This approach proved to be unsatisfactory because of the difficulty encountered in recognition of and planning for transportation facility influences on multi-resource uses. (19)

According to the Technical Report the planning process used by the Forest Service in the early sixties to update previous planning work was not procedurally uniform. (19) Funds were appropriated and justified for forest system roads and trails on the strength of less than comprehensive management plans. Because of this budget justification method, forest access plans were biased towards high standard road systems. Another problem that arose from the non-uniform planning was the lack of standardized planning assumptions. Each National Forest developed its transportation plans with its own assumption regarding future technology and use patterns. (19)

Since the 1960's, the Forest Service has recognized the importance of improving its planning processes in order to more effectively respond to the growing and changing demand pressures from the public for more diversified recreational use of the National Forests. Increased public sensitivity to human impact on the environment and the higher values the public now places on the preservation of natural integrity has compelled the Forest Service to develop precise analytical tools and planning processes which can

incorporate these sensitivities and values into the decision-making process. (19)

In response to these kinds of concerns and sensitivities a Transportation System Planning Project (TSPP) was established by the Forest Service in 1965. TSPP has concentrated on developing, testing, and reviewing methodologies needed to predict the consequences of alternative transportation plans which are influenced by the quality and cost of varying modes. (20) The analysis tools and processes TSPP is developing will be useful for a variety of transportation planning problems. Initial emphasis, however has been placed on the road network, because of its present dominance as a means of circulation within the forest unit. A new forest road constructed for access to some part of the management unit will if necessary be a multipurpose element. Most forest roads constructed to improve fire protection may also accommodate timber management, range management and outdoor recreation. This multifunctional, multipurpose approach to transportation management use complicates forest road planning and economic analysis. Several problems are encountered, "... foremost among these is the problem of evaluating the aggregate benefit to be derived from the project," and "...a second problem arising from multiple purpose projects is the possibility for conflict of interest between the purposes." (20) A road built for timber harvesting can later be used for fire protection and recreational use if it is planned properly. The cost of the road can be charged to the benefits derived from all uses, if these can be quantified. Because of the standardization of wheeled vehicles, the one road can accommodate logging trucks, fire trucks, private automobiles and other recreational vehicles. With certain limitations on road grade, width, and curve radius the road can be used by all wheeled vehicles, regardless of the planned short-range principal purpose use.

Economic Evaluation of Alternatives to the Private Automobile

Applying the assumption that improving transportation systems for wildland areas necessitates a shift from almost exclusive reliance on the private automobile to some alternative, necessitates more precise economic assessment of the cost-benefit relationship. There are existing methodologies for cost evaluation of certain elements within the system. (21) For example, the computer systems developed by the Forest Service's Transportation Analysis Group (TAG), formerly called the TSPP, apply analytical

techniques and systems planning concepts to transportation planning. TAG has also developed and implemented Analysis Systems which aid in displaying alternatives and differences among alternatives, and Data Systems that provide basic information needed in formulation and evaluation of alternatives are being developed, tested and used. (21) The work done by TAG is directed towards the existing specialized planning problems encountered with the application of existing transportation technology.

The TAG timber transport analysis methodologies are probably the only ones ever developed for wildland areas that incorporate several vehicle-link combinations. Sky lines, balloons, helicopters and other new systems have excited planners trying to solve the total stump-to-mill transportation problem of timber harvesting. (22)

Economic evaluation of transportation for use in management appears to be a less complicated task than evaluation of recreation transportation alternatives. Although various researchers in recreation transportation analysis have made considerable progress towards seeking solutions recreation transportation planning problems, the techniques for forecasting recreation travel are in their infancy. (16) To arrive at some method of evaluating the costs of alternative transportaation systems requires careful analysis of each individual problem. There are two categories into which these problems can be placed. These are: 1. Development of some form of access into an area that does not presently have a circulation system; 2. A change from the existing transportation system to one with different network or modal characteristics.

An example of the first category is the proposed circulation system for Guadalupe Mountains National Park, Texas. This 76,468 acre National Park which was established in 1972 "is totally lacking in the essentials necessary for public use, ..." (23) Public use of the park has been hampered by lack of vehicle and other access to the fragile natural resources located in the park.

The Draft Environmental Statement for the Guadalupe Master Plan (23) lists a proposed "mechanical lift system" as an integral part of the park's development. The master plan recognizes the vulnerability and perishability of the fragile ecosystem comprising the park, and the magnitude of environ-

mental stress intensive and uncontrolled visitor use could place on this system. Resources of the park include unique ecosystems, historic sites, a relict forest, geological exposures, wildlife habitat unique to the region, and several different vegetative communities.

Guadalupe Peak is the major physiographic feature of the park and offers anyone on the summit views of the park's high country, seasonal salt lakes to the west, and the desert portions of the park some 5,100 feet below.

The "mechanical lift system" proposed would be used as a moving interpretive tool to explain the geology and ecology of the park. The master plan also states that the system "will not be used as an attraction in itself and will not be represented as such." The proposal describes an aerial tram as being around 6,000 feet long with 5 or 6 towers to achieve an elevational difference of 2,900 feet at a maximum grade of 50 percent.

In this case the tram would be the only means of access to the peak except for a lengthy foot trail. It would be hard to estimate with any accuracy the user demand for the tram ride. The tram capacity would probably be determined by the capacity of the upper terminal and adjacent area rather than by actual demand for the ride. (23)

Examples of the second category, that is -- a change from one transportation system to another with different characteristics are more common. In many recreation areas there are problems associated with the use of the private automobile that a shift to a different transportation system would potentially solve. Yosemite National Park is one of the more frequently quoted examples of a switch from one system to another with better characteristics. Internal park circulation is now accomplished with the private automobile but also eliminates the automobile itself. (24)

Economic Considerations

Increased operating costs for all vehicles is in part a result of fuel shortages. Gasoline prices have steadily risen, in fact doubling in some areas. Theoretically this should result in decreased demand. The Director of the Energy and Minerals Program of Resources for the Future (14), Hans Landsburg, suggests that "... with our scant knowledge of price elasticities of energy as a whole and of its components suggests more about

the direction of change than about its likely magnitude." Prices of conventional petroleum based fuels will no doubt continue to rise and may ultimately be allocated on the basis of the consumer's willingness and ability to pay the unit market price.

Landsburg (14) notes that because consumers purchase energy in driblets the demand reducing effect of price increases is diminished. Speed reduction, the shift to compact cars, and increased use of public transportation seem to indicate that Landsburg's thesis is correct.

An important consideration of most types of planning is the identification and comparison of alternatives. In transportation planning, economic comparison of alternatives is important and, according to the literature, extremely difficult. The San Diego County Comprehensive Planning Organization, after analysis of available transportation hardware, noted that:

> Analysis of costs is critical to transportation planning. Cost analysis is also one of the most complex and misused aspects. Many different cost figures were obtained from manufacturers or were estimated by staff. Two conclusions can be drawn from this experience:
>
> -Cost figures which are usually quoted (cost per mile, etc.) are close to meaningless. This is because assumptions are rarely stated. Adequate cost analysis can only be made with specific route layouts and service levels . . . (25)

This point of view is concurred with in an inventory of existing modes conducted by the Journal of Urban Transportation for the Urban Transportation Research Council, (American Society of Civil Engineers) which states that:

> It is an error in scholarship to make direct cost comparisons within a category (e.g. rapid transit cars.) It is simply meaningless in different categories (e.g. rapid transit car x vs. bus y) unless all variables involved are considered - capacity of the vehicles, the density of the area to be served, labor force for maintenance and operation of the entire system, construction requirements, useful equipment life, cost of money, compatability, etc. (26)

Economic evaluation of alternatives is essential in seeking the most feasible alternative; however, as shown above, planners must be extremely careful in selecting the manner in which the comparisons are made.

Summary

Users of wildland recreation areas depend upon existing transportation systems as a means of access to the areas. The transportation system in this country is almost exclusively dependent on private automobile traveling on publically financed roadways. In heavily used recreation areas this form of access has created problems because of numerous conflicts between large numbers of autombiles and their attendant facilities and those who seek a more natural, undisturbed recreational experience.

Chapter IV

State of the Art Assessment of Transportation Technology Relative to Wildland Areas

Transportation Technology

New developments in transportation technology appear frequently in the literature, but major changes "on the ground" appear less often. Before any new transportation concept becomes operational, two important preconditions must exist: (1) There must be an ussatisfied demand for the benefits the concept can provide, and (2) the new concept in development must technically, financially, economically, and institutionally feasible. (27) There are two kinds of transportation changes: entirely new transportation system, and modifications of existing systems which result in a substantial improvement over the old system.

Elements of existing transportation systems are constantly undergoing change. The automobile, as a mode of transportation, changes yearly when new models are made available to the public. Theoretically, it would not appear that one type of automobile could be responsive to all public demands for transportation.

Essentially, transportation demand is the desire or necessity of moving people or goods from one point to another; within the parameters of personal and public preference costs, safety, speed, convience, comfort, and so on.

New transportation system concepts are primarily new hardware approaches to connecting two points with some improvement in one or a combination of the basic parameters. Usually there is a trade-off situation involved among the parameters, with costs generally increasing as the other parameters realize increased beneficial values. In a discussion of new proposals for unconventional guide-ways (Monorails) Richard Solomon (26) commented that existing forms of transit are not perfect, but complete aboandonment of all concepts of working systems must be justified by evidence that the alternative schemes will accomplish the same functions more effectively or economically.

Currently, transportation technology has been used to make possible the connection of almost any two points. Even the frontier of outer space has been opened by the several successful round trips of men to the moon. Technology is out of the mere concept phase as far as making the connection between points; new concepts and developments are oriented towards improvement of the basic parameters, within the feasibility constraints.

Although there are many people who do not have mobility or the degree of transportation flexibility they perhaps desire, the currently articulated transportation problems in this country are related more qualitative concerns, rather than quantitative aspects.

Any discussion of modern transportation options requires categorization because of the number of inherently different systems in existence or under development. The Institute of Transportation and Traffic Engineering at the University of California (27), categorizes new and novel modes of passenger transportation systems into the following categories:

"1. Pedestrain Aids (moving sidewalks and similar devices).
2. Public Automobiles (comprehensive rental car systems).
3. Small-vehicle transit systems.
4. Bus Systems:
    a. Demand-activated systems for collection-distribution applications.
    b. Exclusive lanes or guideways for line-haul operations.
5. Dual-mode, automated automobile systems:
    a. Electronically controlled and guided systems.
    b. Mechanically guided automatically controlled systems.
6. Piggy-back systems for high speed, line haul of small vehicles.
7. High-speed railroad systems.
8. Supplemental systems:
    a. Ferry boats; hydrofoil boats, and air-cushion vehicles.
    b. Vertical or short take-off and landing craft."

This categorization of transportation hardware is useful because of the great differences that exist among passenger transportation options.

The San Diego County Comprehensive Planning Organization (25) has listed most of the transportation option classification approaches now in use. Most of the approaches organize systems according to their common

operational and structural characteristics. These approaches are:

1. Length of trip
    a. very short trips (1/2 miles)
    b. short trips (2 miles)
    c. medium trips (10 miles)
    d. long trips (75 miles)
    e. very long trips (greater than 2,000 miles)
2. Route Selection
    a. fixed
    b. user adjustable
3. Schedule of vehicles
    a. fixed
    b. user adjustable
4. Ownership of vehicles
    a. public
    b. company
    c. user
5. Number of persons per vehicle
    a. personal (1-6)
    b. mass (7 or more)
6. Vehicle support
    a. rubber tired
    b. steel wheels
    c. air cushion
    d. magnetic levitation
    e. air foil
    f. other
7. Required user skills
    a. moderate to high driving skills
    b. minimum driving skills
    c. no driving skills
    d. handicapped
8. Propulsion Unit
    a. electric (AC and DC)

b. reaction motors

(Example: Jet turbo engine)

c. internal combustion - reciprocating

d. internal combustion - rotary

e. external combustion

f. fly wheel

g. user (Example: Bicycle)

9. Service Orientation

a. Demand responsive (systems adjust the routes and schedules of vehicles to the individual).

b. System oriented (modes have fixed routes and schedules, user must adjust his life style to the requirements of the system).

The type classification system that best organizes the array of options so as to be responsive to the transportation planner's selection criteria is the most desirable. The classifications can be modified to fit individual needs. Their importance is that they display the range of feasible alternatives.

The San Diego County Comprehensive Planning Organization (25) continued by summarizing the identifiable user-preferred features of the attributes used for the various classification schemes.

"The following features seem to be preferred:

--relatively fast travel times regardless of trip length

--continuous or user adjustable schedule

--adjustable route selection

--personal size vehicles

--demand responsive systems

The characteristics for which users did not have any clear cut preferences were:

--ownership of vehicles

--vehicle support

--required user skill and capability

--propulsion unit.

Vehicle Technology

Passenger vehicle technology has undergone critical review in the past few years. This has been stimulated in part because of increasing pressure to attract people away from exclusive reliance on the private automobile which is used for the majority of both commuter and around town trips. The underlying assumption is that an alternative transportation mode must be more economically and personally attractive to the traveler than his private automobile before it will be accepted appears reasonable. It also would appear reasonable that the alternative will be acceptable for necessary trips if the traveler is denied use of his automobile, or severely penalized for using it over another mode.

Several different modes have the potential of being valid alternatives to the private automobile for wildland use. The bus is the alternative mentioned most frequently in the literature; therefore, it will be discussed here.

Other promising modes are discussed in Appendix B. Because of the publicity mass transportation proposals are receiving, capacity-cost data is presented in Table 1.

It illustrates the tremendous costs and necessary passenger volume associated with these systems. It is important to keep in mind, the cost of candidate systems relative to capacity, especially in recreational areas where demand is dynamic and seasonal which results in greater fluctuating demand curves.

The Bus: An Alternative to the Automobile

The word "bus" is applied to many types of passenger vehicles, quite appropriately, according to the definition of the word. The dictionary defines bus as: "A large passenger vehicle . . . " (28) Another more descriptive definition encountered in the literature is: "Buses are essentially rubber tired, mass transit vehicles which are driven on existing streets and highways . . .normally seating 30 to 50 persons, but with extreme ranges of 15 to 72 passengers. (29) Buses are currently one of the least expensive modes of mass transportation in terms of capital costs (typically $50,000 each). (29)

Table 1

Capacity--Cost Data for Various Systems (1974 Costs)

	Capacity (Passengers/hour)
BART (Bay Area Rapid Transit)	
Vehicle $200 thousand	30,000
Terminal $2,740,000	
Corridor $4.69 million/mile	
MONTREAL METROLINER	
Vehicle $123,000	20,000
$12.3 million/mile	
ALWEG MONORAIL (Tokyo)	
Vehicle $408,000	2,500
Terminal $263,000	
Corridor $1.59 million/mile	
SAFAGE MONORAIL (France)	
Complete $2.5 million/mile	30,000
AEROBUS (England)	
Complete $6 million/mile	500
LONDON AERIAL TRAMWAY	
Complete $6.4 million/mile	1,200
BUS-TRAIN ON EXCLUSIVE RIGHT OF WAY (General Motors)	
Vehicle $30,000	36,000
Terminal $186,000	
Right of Way $1 million/mile	
TRANSIT EXPRESSWAY (Westinghouse)	8,000
Vehicle $94,000	
Terminal $1,200	
Road of Way $2.14 million/mile	
TROLLEY BUS (San Francisco - Electric)	
Vehicle $32,000	10,000
Road of Way $1 million/mile	
MINIRAIL (Habegger - Small Monorail)	
$1 million/mile	2,500
SCAT (Veyar - D. Fichter)	
Vehicle $1,500	2,500
Terminal $13,000	
Road of Way $1 million/mile	
SKYLIFT (Lockheed - Rubber Tired Gondola)	
Complete $1.65 million/mile	4,000
PEOPLE MOVER (Goodyear)	
Complete $5 million/mile	2,400
AERIAL TRAMWAY (Heron - 50 Persons)	
$300,000/mile	200
MONITOU & PIKES PEAK RAILWAY	
$1 million/mile	80
BUS (Greyhound Type)	
$50-70,000 initial cost	
Average cost/mile (1973) $.737	

Examples of Bus Use

A bus can be utilized in various ways because of the great diversity of sizes and models available. The Disney World Transportation System at Walt Disney World in Florida, for example, uses four types of buses to move people around the area. The system utilizes one 19-passenger bus, three 23-passenger buses, five 75-passenger buses, and six 70-passenger coaches. In additon to the buses 29 natural gas-powered, 150 passenger trams are used. The trams are essentially several open bus compartments towed by one power unit. A bus to meet exacting transportation requirements for each part of the Disney operation has been designed. (30)

The City of Philadelphia uses buses on special routes for cultural interpretation. The Philadelphia "culture loop" uses conventional transit buses to transport passengers to many of the cultural and historic sites located in the city. (31)

In Europe, buses are used as part of a new tour concept: The Hotelbus. The Hotelbus concept consists of two vehicles, the Hotelbus itself, which is a van divided into compartments that sleep 39 persons in comfortable bunks, and a second vehicle which is a conventional coach bus that carries 50 passengers who select the routes for 15 to 22 day tours. (32)

In more conventional situations, the bus is utilized as a transportation alternative to the car in various highly congested recreational areas. The Shuttle Bus system designed for use in Yosemite National Park has responded to the transportation planning objectives set by the Park Service. It is "Free, Fun and Frequent." The Yosemite system utilizes either liquified propane or liquified natural gas burning power plants to reduce air pollution. Vehicles used include the Mini-bus, which is a four unit tram carrying 125 to 150 passengers, and an ACE Trailer (American Carrier Equipment Co.) double deck bus with a capacity of 115 to 160. The first year's operating cost to the Park Service was $550,000 for 235,000 vehicle miles. This figure included all overhead costs and construction of 23 lighted bus stops at $1,000/stop. The system is contracted to the park concessionaire on a cost-plus basis. The Park Service estimates actual cost of operation at $0.66/vehicle mile plus a fixed monthly cost of $11,000. (33)

Specialized Bus Design

Most passenger vehicle manufacturers offer a base line of models and built-in options as requested. Most bus supply companies will custom build buses to the specifications required by the user. Models are usually classified according to passenger capacity with a wide variation of power trains, color, and optional equipment available.

Probably the best known custom recreation transportation system supplier is the Mini-bus Corporation of California. Mini-bus offers a line of vehicles running from 18 passenger, all-purpose buses to 200 passenger trams. Double-decker buses and articulated dual-section buses are also available. (34)

Prices of mini-bus equipment vary according to the nature of the unit. A standard transit mini-bus runs in the neighborhood of $30,000-$45,000. A three car tram, such as those operating in Yosemite and Mesa Verde National Parks, ranges from $65,000 to $85,000. A small open sided vehicle would cost approximately $34,000 to $44,000. (35)

Many manufacturers recommend propane fuel for economy of operation, suitability and relatively pollution free exhaust, particularly when designed for wildland areas. (35) In Yosemite National Park Liquified Propane Gas (L.P.G.) is used for bus fuel while Park Service vehicles operate on Liquified Natural Gas (L.N.G.). (33) These fuels are used rather than gasoline or diesel because they produce low levels of emmisions. (33) Mini-bus equipment, for example, can be ordered to operate on any of these fuels as well as electricity. (34)

One of the advantages of selecting a custom built bus unit for a particular recreation area use is the capability of the manufacturer to build or modify vehicles for each potential application. According to Mini-bus Company literature:

> MINI-BUS, to design and manufacture creative transportation systems, needs to know application, location, speeds, grades, available area to operate, number of passengers to be moved, and the theme to be captured in the design. With this information Mini-bus will develop a design, specification, and cost to meet your transportation system requirements. (34)

Bus Technology Development

One of the major areas of bus technology development activity deals with the propulsion unit. Turbine engines have been installed experimentally in several buses; however, they are still under development. The turbines are smokeless, odorless, and vibration free. They weigh up to one ton less than a comparable diesel power unit and utilize a synthetic lifetime lubricant that does not need changing. The turbine, however, does not lend itself to start-stop bus operation and is not presently competitive with the diesel in terms of initial cost or fuel economy. (36)

Use of electric motors for power units is also a current area of interest. Electric street cars and trolley coaches were acclaimed at one time because of their reliability, long life, low maintenance and ecomomy of operation. As one study observed, "Their requirements for external power restricted their use to applications that could provide the dedicated right of way." (37) Overhead power lines as the power source does not lend this type bus to use in natural areas, and few cities would accept the aesthetic tradeoff required to install these systems. One answer to this conflict is battery powered buses which combine all the advantages of electric transportation with the route flexibility offered by conventional buses. An example of a battery powered electric bus is the Electrobus produced by the Tork-Link Corporation which operates on a large lead-acid battery of advanced design. The bus has a range of 40 to 50 miles on one set of batteries, which can be changed in five minutes. Frequent acceleration and climbing steep hills limits the range because of accelerated battery drain. The electrobus initially costs more than its conventional counterpart, but the manufacturer claims that the 25-year in-service life makes the electrobus competitive price-wise with other buses. (37)

The nation's first battery-powered bus system in Lansing, Michigan, failed because of poor ridership and a rash of mechanical problems. According to officials, in 1973, six 20-passenger units built by Battronic Truck Company of Boyertown, Pennsylvania, were purchased by the City of Lansing for $22,738 each. These buses were powered by twin 1400-lb lead acid batteries. The Capitol Areas Transportation Authority reported that as many as three of the six buses have been out of commission at one time for repairs. A

spokesman for Battronic attributed the mechanical problems to improper maintenance. (38)

Propulsion Units

There has been much discussion in recent years regarding alternate power units for passenger vehicles. The current "standard" is the internal combustion-reciprocating engine that converts petroleum products, primarily gasoline and diesel, to energy that can be used to propel a vehicle. There has been continuous research to improve the efficiency of conventional vehicle power plants and to develop more efficient alternative engines. Between 1963 and 1973, General Motors Incorporated, (GM) claims to have made technical reviews of 334 alternate power plant proposals. (39) The GM Research Laboratories (39)stresses that the spark-ignition gasoline engine remains as the strongest competitor for future power plants because of its years of evolution and development. GM points to such recent developments as advanced emission controls, the rotary combustion engine, and various engine modifications (such as dilute combustion) that prolong the useful life of the internal combustion engine.

Efficiency in the combustion or consumption of fuel is particularly important because it directly indicates operating costs and air pollution emission levels. Three approaches to lower emission outputs of conventional engines are being used: (1) change to different engine concepts, (2) modify of existing engine concepts, and (3) add-on hardware. (40) The Wankel Rotary engine, turbine engine, and external combustion engines are examples of the first category. Both diesel and gasoline engines can be converted to utilize alternative fuels, and improvements such as solid state ignition system and improved head design are under development. (40)

Current Propulsion Technology

Robert J. Fruedenberger, Jr., Executive Technical Editor of Motor Service Magazine (41), and his staff have picked six of the more promising engine concepts as having the potential to overcome current difficulties. These concepts are: stratified charge, the Wankel Rotaries, turbines, diesels, stirling, and electrics (including hybrids). Fruedenberger discusses the characteristics of each as follows:

Stratified Charge

This is not really a new engine, but rather a modification of an existing power plant and therein lies its greatest advantage. New head, valve trains and intake systems replacing the ones on existing internal combustion engines will increase mileage and decrease emissions. The Honda Corporation is producing this type of engine with their version being called the CVCC (Compound Vortex Controlled Combustion). Fruedenberger states that the stratified charge concept is not a long range answer to the power plant problem but is quite feasible as a solution for the interim. (41)

Wankel Rotary

This engine is extremely smooth and light weight for the power it produces. Another advantage is the small number of moving parts. The Wankel's major disadvantage is that it is less fuel efficient than conventional engines and while it produces less nitrogen oxide (NO_x) emissions than the conventional engine, it emits more hydrocarbon (HC) and carbon monoxide (CO) pollutants. Fruedenberger predicts that if "some of the Wankel's basic drawbacks are minimized through engineering they could become a major segment of the auto engine population." (41)

Diesel

The diesel's major advantage over conventional engines is its fuel efficiency. Its disadvantages are its characteristics of being "noisy, rough, heavy, and expensive to build, its narrow r.p.m. range, and the smoke it produces," Properly tuned, the diesel emits very little HC and CO but relatively large amounts of NO_x. Fruedenberger predicts that more diesels will be used as power plants but they have too many disadvantages to become a large factor on the market. (41)

Turbines

Despite the great amount of money and time that has been spent on the development of turbine engines, Fruedenberger states that their basic disadvantages will keep them from being a major replacement of conventional engines. They are smoother, lighter, and smaller than similar power piston engines, and produce quite low emission levels, but they are expensive to build due to the temperature and speeds they produce, and they are not nearly as fuel efficient as the conventional internal combustion power units. (41)

Stirling

The Stirling engine concept is extremely exciting because of its potential thermodynamic efficiency of about 40 percent, which is slightly better than the very best diesels, and much better than the 15 to 20 percent efficiency of conventional gasoline engines. It can run on any fuel or heat source (even the focused rays of the sun), and its external combustion design gives the lowest emission of any engine. (41)Fruedenberger concedes that because of design characteristics the Stirling engine would be large and expensive to build, but once the bugs are worked out he says it has the theoretical potential to "alleviate most of the automobile's troubles far into the next century." (41)

Electrics and Hybrids

The electric motor has been attacked on its proponent's claims of no air pollution emissions because the pollution occurs at the generating station. Fruedenberger challenges the logic because the emissions could be controlled in a relatively small number of point sources easier than would be possible at a infinite number of mobile sources. It is also feasible to generate or collect electrical energy in numerous ways that do not produce air pollutants.

The other main argument against electrically powered vehicles is the limited range possible with present storage battery technology. Cost is the main constraint to the high capacity low weight batteries. This area is currently being researched by several organizations. The electric hybrid is one of the present solutions to the battery problem. This concept utilizes batteries for the drive motor and a conventional engine is used to recharge the batteries. The engine would have lowered emissions and higher economy because of the constant rpm used. The major disadvantages to the hybrid are the size and weight of the double running gear. Fruedenberger concludes that the Stirlings and electric power plants have the greatest potential for future power plants. Fruedenberger predicts that once the electrics come into prominence they "will rule for generations." (41)

CHAPTER V

Characterization of Recreational Travel

Transportation Planning

Technology is no longer the major constraint on comprehensive transportation planning. Technically, man can and has put men on the moon, not only by themselves, but with a vehicle to travel in. One major problem that has led planners to re-evaluate transportation technology and the transportation planning processes is that presently utilized modes of transportation produce undesirable side effects such as noise, pollution, and large-scale consumption of irreplaceable fuels. (42)

In past years planners were limited by the number of alternative modes available. Hypothetically, transportation planning has been a fairly simple process; if you wanted to get from here to there, and could pay for it, all that needed to be done was decide on the route and build the tracks or roadway. Today's planners are concerned with more sophisticated evaluating procedures such as the Cost-Benefit Analysis method of project evaluation in which direct and indirect benefits are weighted against direct and indirect costs. In a transportation study, benefits could be such things as reduction in accident costs, increased convenience and comfort, and decreased noise and air pollution. The costs could be such things as the actual economic costs of construction, social impact on residents, and negative effects on public recreation areas and historic landmarks. (43)

In addition to the many faceted cost benefit analysis procedure the planner's job is complicated further because of the alternatives available from which to pick the most desirable mode. Not counting the conventional methods of transportation such as automobiles, trucks, buses, and airplanes, a Special Report from the Institute of Transportation and Traffic Engineering at the University of California, entitled, New and Novel Transportation Systems (27), lists almost one hundred different vehicle designs for moving people. Designs range from the People Mover, which is a small vehicle propelled by electrically driven rubber tires fixed in a road bed, to Marine Air cushion vehicles which can carry passengers and conventional cars at high speeds over water.

Transportation systems planning is becoming recognized as a science despite its origins and practice as a largely intuitive process. (27) Cantanese (44) follows the development of transportation planning methodologies from the 1040 home interview sampling work done by the Bureau of Public roads up to the computerized mathematical models of the 1960's which use large masses of data concerning the dependent and independent variables affecting transportation. Most of the mass transit methodologies in use today are the results of studies conducted for mass transit proposals in the large metropolitan regions. In 1970, the New York City Metropolitan areas had one billion, twenty million dollars earmarked for the Metropolitan Transit Authority. Washington, D. C. began work on a 2.3 billion dollar rapid transit system. Other transit projects from Chicago to San Francisco were being planned and built. (44, 45) The technology for mass transportation is available and the planning methodology is becoming more refined; Chicago has rapid transit trains, Tokyo has a monorail system, and the University of West Virginia is installing the controversial 'people mover.' Pittsburgh, San Francisco and other larger cities also have modern rapid transit systems in or near operation. (42) Mass transportation is beginning to be an important element of urban planning.

Recreational Travel

Wildland transportation analysis and planning becomes very complex for several reasons. John P. Thomas of the Hudson Institute (46) in talking about the Northeast Corridor stated that: "...it should be understood that transportation in and of itself is not a goal, but rather a means of achieving a multitude of economic and social purposes at either end of the trip." For transportation in general this may be the case, but researchers of recreational transportation have found that up to 86 per cent of the drivers in recreational trips enjoyed the time spent travelling. (47) Travel is both a form of recreation itself, and a fundamental component in most outdoor recreation. O'Rourke in a study of recreation transportation observed, "Indications are that in many cases the pleasure of the car ride is as important as the destination." (48) The study of wildland transportation can become caught up in verbal contraditions such as shown above, even though these do not appear to be important. One question that must be asked by the student of wildland transportation planning is: 'If basic

contradictions exist between the recreational aspect of transportation and the general transportation concept, can the same methods be applied to the planning of both?' At this time, there is no definitive answer, but because recreationally oriented transportation is an element of, and dependent upon the general transportation system, methodologies applied to the general system may be lacking in validity when applied to a specific subunit. R. I. Wolfe (48) cautions that: "It is not enough simply to utilize the techniques that have been found valid for the analysis of traffic flows on urban streets and non-recreational highways for these have traffic patterns that differ fundamentally from those on recreational highways.

Karl Leonhardt (49) found it necessary to classify recreational trips into seven purpose categories for the State of Washington. The purposes Leonhardt identified for the State of Washington are camping trips, hunting trips, fishing trips, visiting beaches and clamming, snow skiing, driving for pleasure and sightseeing, and "others." (49)

One of the reasons for the purpose category was because of the differences in travel behavior observed in connection with trip purposes. He found that certain purpose or activity oriented trips (hunting trips, fishing trips, and so on) have distinct destinations and the trip maker selects the shortest route in order to minimize travel time. For activity oriented type trips, the recreational experience while travelling to the destination ranks second to the experience of the trip purpose, in terms of the recreationist's time value. Leonhardt went on to contrast this category of trip purposes to pleasure and sightseeing travel where the trip to the recreational site is an essential part of the experience. Travel time here should not be minimized necessarily because this shortens the time period of the recreational experience. Quality of the experience would have to enter into this type of approach before a planner could evaluate the relationship between travel time and quantity of the experience. (49)

The area of driving for pleasure has been recognized as part of the recreational experience, but this is an area that needs more research to develop findings that can be used by the transportation planner. Assumptions about the recreational experience, and travel by private automobile cannot be validated because the average person does not have a comparable alternative available to choose from. This aspect of travel deserves further study,

especially when related to wildland areas. By their very nature wildland areas permit the user to seek solitude because of the lower density of people encountered. It may be possible that the recreation planner may unconsciously create latent preference for wildland recreation if there is a substantial shift in transportation policy. If mass transit is incorporated (into urban areas) as the primary form of transportation to these areas, the average citizen may be indirectly denied the opportunity to find solitude. Such a radical shift in public and private transportation may be too future oriented to be given serious consideration at this time; however, current technology and resource shortages may demand such considerations.

Travel Patterns

Any trip, regardless of whether it is urban or rural in nature has certain elements in common. The common characteristics of trip making have been identified and used in models to explain current travel patterns with the goal of developing tools to accurately forecast future travel patterns. Such forecasting is needed to insure the viability of future transportation systems.

Every trip has an origin and a destination, or in other terms a zone where it is produced and a zone where it is attracted. John Dickey (50) presents four general elements that should be examined in the determination of future travel patterns: Trip Generation, Trip Distribution, Mode Choice, and Route Choice (or Trip Assignment). Dickey defines these terms as:

> "Trip Generation - is concerned with the prediction of the number of trips per time period made to or from a given areal unit of zone. . . . .,
>
> Trip Distribution - is concerned with finding the zones to or from which the generated trips are directed,
>
> Mode Choice - is concerned with the determination of the particular mode of transportation used for the zone to zone trips, and
>
> Trip Assignment - is concerned with the prediction of the particular route that will be selected by travelers going between each pair of zones on each mode of transport." (50)

Aggregate data identifying each of the above characteristics characterizes the travel patterns between two zones. Empirical data is obtained by observation of the system, and census of the system users. Information about the behavior of travellers and about the functioning of the transportation system provides understanding about the systems, and assists in the development of models for use in planning and analysis of transportation facilities. (51)

Forest Service Project Working Paper #7 (51) from the Institute of Transportation and Traffic Engineering, describes the design of a National Forest Travel Survey that could be used to gather needed data. The author of the National Forest Survey, Adib K. Kanafani, emphasizes the fact that although the survey would be carried out on the Tahoe National Forest, neither the Tahoe, nor any other National Forest, can be referenced as "typical." Data from the specific area to be planned for must come from that area to reflect its inherent uniqueness. Kanafani also points out that although this survey is directed at recreational traffic, other types of travel are also important. It was felt that information concerning other types of travel encountered in the National Forests could be obtained without a "sample survey." (51)

In this survey, model characteristics would describe the range of private vehicles used by recreational travelers. With the exception of charter bus trips and commercial sightseeing tours, National Forest visitors have access to the Forests only by private vehicles. (51) For the purposes of this survey, recreational travelers were divided into three groups: Recreationists in the Forst (residence not adjacent to the Forest), Residents of the Forest and immediate vicinity, and Recreationists travelling through the Forest (Touring). Information on travel activities within the Forest would be composed of trip prupose, origin and destination, time of trip, type of vehicle used and route traveled. It is interesting to note that some vehicles bringing people into recreation areas are also transporting secondary vehicles (i.e., minibikes, canoes, off-road vehicles, etc.) that the visitor will use in the area.

Travel Analysis

Before any transportation system evaluation or analysis can be undertaken, the travel demands must be identified. This has been done several

times with little actual differences in the listings. Wong, Barriga, and Carder (52) listed the following constituent types of forest traffic:

-Recreation

-Logging

-Logging-associated (e.g., water wagon, crew truck)

-Government (e.g., timber sale inspection, fire patrol, campground maintenance)

-Local Residents, including commercial (e.g., ranching and service industries)

-Through Traffic

These investigators also point out that the first four types dominate the traffic makeup on forest roads, and present data showing the volume of traffic generated by vehicles in each category.

Others simply consider travel types as either recreational travel, or non-recreational travel. (53) The classification scheme used makes little difference because most cover the same material. It is important to keep in mind that the local resident and through traffic travel types contribute volume to the total system and may be somewhat more dependent on the network for year round use.

Both of the traffic classification schemes have been concerned with the type of activity the traffic is related to. Activities can be grouped under the headings Resource Development, Resource Protection or Resource Use. (54) From this it follows that non-recreational travel is primarily associated with the first two groups (not exclusively) and recreational travel is primarily associated with the Resource Use activity group. Management of the transportation system itself is an activity that falls broadly into all three groups.

The Forest Service Management Sciences Staff suggests that if transportation systems play a vital role in urban land locational decisions, evaluation, and the development of urban land, then they may also play a similar role in the patterns of development in wildlands. (55) For this reason, transportation planning is not an activity to be taken lightly. Some ninety-five percent of all person-trips to recreation areas are made in personal cars or recreation vehicles. (56) With few exceptions, wildland

recreation areas do not have any regularly scheduled form of public transportation available to users. Thus thepresent wildland transportation system can be generalized as being a system accessable only to those who have use of a private vehicle.

The existing wildland transportation network are primarily conventional road networks. Vehicles used in almost all activities associated with wildlands are usable on these networks with no modification because of the standardized nature of most vehicles. The personal automobile can be used on most surfaces that logging trucks, fire trucks, cattle trucks, and so on operate on. The transportation planner should immediately take notice of the fact that roads on public lands administered under the multiple use concept are multiple use themselves.

Travel analysis leading to a transportation plan for a wildland area must consider the adjacent land uses and estimate the specific travel demands they will place on each link of the network. This step is usually done when the question of financing arises. Justifying government projects is normally easier if the projects will serve several uses. (20) A road system initially constructed for timber harvesting activities may be left for administrative, fire, and recreation travel.

Demand for recreational travel has been calculated for several areas; the Tahoe National Forest in California and several State Parks in Washington State are two of the numerous examples. (51, 49) Both macro- and micro-generation models have been developed to estimate recreational travel. The macro-level models predict the distribution of generated trips to the destination zones, while the micro-level models predict distribution within a destination zone. (57) These demand methodologies are based upon the assumption that the area user will continue to provide his own transportation to the area and for travel within it.

Some mention should be made of recreational trips made for the purpose of allowing the recreationists to participate in activities that require extensive equipment. Trips made for "trailer" camping, fishing, hunting, and so on, suggest equipment and/or baggage requirements that can best be satisfied with the use of the private vehicle. No feasible conveyance exists to move both the recreationist with his self contained camper and his

trailered boat from forest boundaries to a lake. To arbitrarily prohibit the use of private automobiles in an area that has been accessible will raise protests from people who have invested large amounts of money in expensive equipment to be used in wildland areas.

In some instances it may be "convenient" for a recreation area manager to regulate only the use of certain vehicles. A hypothetical example would be to require owners of large mobile homes to park their vehicles and ride provided public transportation, while allowing the operator of smaller private vehicles full access to internal circulation systems. This action may be partially justifiable because of the differences in spacial requirements made by the two types of vehicles, but there is some question about the legality of this type of "descriminatory" regulation. (58)

Wildland transportation analysis has not been directed towards selection of alternative modes because traditionally the users have supplied their own vehicles. Wildland managers have had only to concern themselves with support facilities for the user supplied vehicles, and occassionally with the evaluation of small scale special use permits requested by the private sector for transportation systems designed for special activities. There has not been the great need to differentiate between network boundaries, because networks inside the area boundaries were compatible to outside networks and the vehicles operated on them. Environmental issues, the decrease in publicly accessable wildland areas, and the resultant quest for maintaining or improving the quality of the recreational experience are important considerations in wildland transportation planning. It would be hard to improve the existing concept of recreation transportation wherein the managers provide the road or link, and the area users provide the vehicle, without major alterations of the existing regional transportation systems. The only practical way to evaluate the transportation system within wildland boundaries is to separate it as much as possible from the outside system and study each separately, and the relationships between them. Looking at the transportation system as a whole, it is fairly evident that recreational circulation systems <u>within</u> established wildland boundaries are relatively small subsystems of the entire regional transportation system. This has to be qualified because various study commissions including the highly publicized Outdoor Recreation Resources Review Commission Report (2) suggests that driving for pleasure is a recreation experience itself. This

can complicate an evaluation of recreational transportation, if the assumption is not made that travel to the recreational destination can itself be part of the recreational experience. The actual travel experience (i.e., "driving for pleasure," "scenic drive," etc.), does not respect recreational area boundaries as much as the primary recreational activity. To further explain this point, take the hypothetical case of a vacation family who goes from West Texas to Colorado to camp and fish for a week. Some national forest is the destination and location for the primary experience. The drive between the two end points must also be considered even though it crossed two or three state lines, several municipal boundaries and probably several national forest boundaries as well as public lands administered by other governmental agencies. The recreation planner must limit his evaluation of the experience to some radius of his management area; simple logistics suggests that the planner must only be concerned with that portion of the experience that takes place in his area. The transportation planner for the national forest must likewise be concerned with the network within forest boundaries, and its connection to the outside network. This is probably done almost unconsciously; the forest network is dependent on the adjacent networks, and portions of it may actually come under the jurisdiction of the county or state for construction and maintenance. National forests are frequently crossed by roads that link networks outside of the boundaries. In these cases the Forest Service cannot independently alter the portions on their lands in any way that would alter the functions of the total network.

An evaluation of alternative modes for wildland areas by itself would not be complete without an evaluation of the total system. Mode evaluation necessitates a comparative evaluation of alternative, including each mode's support facility and the alternative system's interaction with the total area transportation system. Relevant planning cannot allow evaluation of alternative systems out of context. This is evident in an open type system. A closed system also must have some common interchange with the total system. For example, a closed system with a capacity of 1000 people per hour will not fill the planned function in a cost-effective manner if the system that links it to the adjacent urban centers accommodates only 25 people per hour.

Figure 1
Modal Structure

- Total Transportation
  - Domestic
    - Highway
      - Auto
        - Personal Passenger
        - Taxi
        - Motorcycle
      - Truck
        - Local
        - Intercity
      - Bus
        - Intercity
        - School
        - Motorbus
        - Trolley Coach
        - Local Transit
    - Rail
      - Cargo
      - Passenger
        - Surface Rail
        - Subway
        - Commuter
        - Intercity
    - Air
      - General
        - Business
        - Commercial
        - Instructional
        - Personal
        - Other
      - Air Carrier
        - Certificated
        - Supplemental
  - International

Figure 2
Vehicle Miles (Millions) - 1971

Personal Passenger
939,102

Auto
954,155

Highway
1,184,606

Domestic
1,192,162

Figure 3
Passenger Miles (Millions) - 1971

Personal Passenger
2,066,024

Auto
2,082,582

Highway
2,108,082

Domestic
2,239,108

There are several major transportation mode systems in operation in the United States that people use in getting from one place to another. A general classification of these includes automobiles, buses, airplanes, and railroads. (10) From Figures 1, 2, and 3 it is very apparent that the private automobile is by far the primary transportation mode in this country. Wildland managers have little control over the means by which people enter the areas they manage. For this reason, the wildland planners are somewhat limited in exercising managment options. The vehicle used to move a visitor from an urban center to a wildland area must be accommodated, even if it is not used for transportation within the area. If the user arrives and departs in a private automobile, that automobile must be parked if it is barred from entering the area.

Recreationists are also transportation system users and this assumption is built into the concept of wildland recreation. In urban centers, users of public recreation areas are not so dependent on private transportation because once there they have more alternatives available to them. They can walk, drive a private automobile, or ride some type of public conveyance. By the very nature of their development, wildland areas are not designed to allow use of more than a few basic vehicles.

Wildland recreation transportation planning is more than the analysis of conventional factors associated with urban transportation. Empirical studies have not established the significance of the actual use of the private automobile as more than a means of transport, but research has established that there are relationships between an ownership of automobile and recreational travel. (16) O'Rourke (48) concludes that although recreational travel has not been satisfactorily modeled at this time, there has been progress made towards that end. Sullivan (58) concurs with this finding by stating that, "Despite several recent advances in systematic analysis technique for recreational travel forecasting, the overall state of the art is weak." (emphasis added)

The planner involved with wildland transportation planning must recognize transportation as:

1. an activity taking place on and off the site,
2. an element of the recreational experience,

3. a resource management/allocation tool,
4. a resource utilization tool,
5. an element of the carrying capacity determination and enforcement process,
6. a set of physical facilities,
7. a dynamic physical process,
8. a potential negative environmental impact source, and
9. a method of providing access.

CHAPTER VI

Conceptual Approach to Planning Wildland Transportation Systems

The transportation plan is one of the major elements, if not <u>the</u> major element, in the comprehensive set of plans for any land management area. The circulation system should respond to the land suitability determinations so as to appropriately accommodate the requirements for custodial management, resource development and protection, and other uses, both consumptive and non-consumptive.

Transportation planning for forest areas is similar in many respects to other forms of transportation planning. The recreational circulation element in the forest environment is different from conventional park planning situations because of its relationship to other ongoing forest uses, which must be accommodated simultaneously or nearly so, the multiple ingress and egress character of most forest road systems, and the presence of man inholdings, some of a substantial nature. Where demands for transportation are highly specialized, there may be conflicts with respect to both link and mode. Planning for the development of new areas and the reprogramming of management emphasis for existing units within a forest provide an opportunity to consider several transportation alternatives.

There are several institutional constraints which must be recognized when developing a framework for a forest transportation system.* These and other factors bear heavily on the selection of the most appropriate transportation system.

Influencing factors may be characterized as fixed or variable in nature. Fixed factors are those which are not easily changed at least in the short run, for a variety of perfectly acceptable reasons without a major effort. Variable factors are those which can be modified, either internally, within the agency structure or externally.

Fixed factors include many of the physical resource characteristics of the national forest areas, the organizational structure of the agency, the basic enabling statutes from which its policy promulgation authority flows,

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* Ecological constraints and considerations are discussed in Chapters 8 and 9.

and certain economic situations which strongly influence operations. Variable factors include the promulgation of certain organizational and administrative policies, technological developments, changing demand for products and uses of national forest lands, energy allocation and fuel pricing policies, funding levels and attitudes and perceptions on the part of the public as a whole towards changes in behavioral patterns necessitated by modifications in conventional leisure life styles which the adoption of certain transportation alternatives would bring about. Changing these attitudes often requires a major effort over a lengthy period of time. The last is perhaps the most difficult to deal with and change will occur only when choice is limited to an alternative mode that is mandated simply because it is the only alternative.

Economics and technology development are important considerations in analyzing transportation components. Few, if any, transportation systems can be single purpose systems and stand the test of economic feasibility. There are, however, several schemes for timber removal which utilize aircraft and other auxiliary systems which are essentially single purpose in nature to augment or supplement the primary multipurpose system. They are very costly and have been developed in response to the need to remove timber from areas heretofore either not readily accessible by conventional means or where environmental factors necessitate a procedure which minimizes the physical impact on the site. Many recreation transportation systems, in addition to being a recreational experience themselves, are utilized for precisely the same reasons.

The forest transportation planning framework must provide a link from the past to the future and in so doing take into consideration all of the fixed and variable factors which bear upon the managing agency. Implicit in this is the recognition that management includes planning and that management is a function of the present which has significant implications for the future. The planning process is a means whereby future goals and objectives are developed along with alternatives and the strategies, for reaching these goals and objectives. Through the management system planning is implemented on the ground. Monitoring the impact of plan implementation occurs through the management program. Results of decisions can be evaluated

through the application of a wide range of evaluation techniques. Because of the dynamic nature of planning, the monitoring data feeds back to the initial phase of problem assessment and the determination of a revised set of needs, goals and gobjectives.

The relationship of recreation to other forest uses must be fully understood when considering a comprehensive transportation system to serve a national forest. It is essential that the major system be capable of accommodating many requirements. In some single purpose areas, a more specialized system may be used to solve a particular planning problem.

Problem identification is the key step in the development of an approach to planning transportation systems. It is essential to try to learn as much about the existing problem prior to proposing probable solutions. In this search process, it is desirable to evaluate early solution ideas. This process helps to sharpen the task of identifying precisely the exact problem for which a solution is needed.

In many cases problems occur when the recreation attraction is institutionally created (identified) without fully thinking through the management implications which most often necessitate additional planning, program development and budgeting activity. A classic example of such a situation is that suggested by Carder (54) where a trail to a scenic resource attraction over time becomes enlarged until it finally ends up as a major highway. The stream of implications associated which this kind of development are usually substantial.

In seeking planning solutions to forest transportation problems, it is essential to recognize the relationship between the forest unit and the transportation systems extraneous to that unit. Forest recreational transportation systems are for the most part internal and site specific. In other words, they are designed to move people through an area from node to node or within a limited area for the purpose of directing or channeling the movement of users through the area with the least amount of resource deterioration, user conflict, and diminution of the recreational experience.

The key element in the recreation transportation planning framework is the capability to align economics, public policy, and user attitudes in response to a particular recreation resource management situation. Con-

struction, operation, and maintenance costs weigh heavily in mode selection. Where new links are required, substantial construction costs are often incurred. Agency policies with respect to the appropriate roles for concessionaires and private developers influence the extent to which more specialized alternatives can be considered. Where significant limitations exist and cannot be easily modified, the viable courses of action are extremely limited, making it often difficult to adopt the transportation mode most desirable from a "service" (benefits) standpoint.

In short, the forest transportation planner in developing his planning framework is confronted with the following situations:

An extensive land area which must be reasonably accessible for a variety of management activities.

An area with many points of ingress and egress.

Often there is a substantial investment in the existing forest road network (links).

Recreational use may be only seasonal and at a volume which is not sufficient to economically justify a mass conveyance system.

Lack of readily available connections (connecting nodes) with external mass conveyance systems. (An example here would be the railraod service to many national parks. Often this is a focal point for visitor accommodations and a principal node on the internal circulation system).

A need to accommodate non-recreational transportation priorities and requirements into certain components of the recreational circulation system.

As was discussed earlier, the development of new recreational attractions provides an opportunity to plan the most appropriate transportation system. Also, as resource management practices change, many links within the existing circulation system may be removed entirely or modified for only periodic use. The forest circulation system, like any other circulation system, is the determining factor in creating certain locational advantages and points of probable or real environmental impact. The transportation system shapes land use patterns; the reverse should not be the situation. In other words, the land capability assessment leads to the delineation of land uses based on their intrinsic characteristics. The transportation system locks in these use determinations and in a sense establishes the

future land use patterns. Without access few areas on a national forest could be developed to serve more than the few individuals who would discover the area and walk to it. While this does not impact on the economic value of the land, (i.e., locational advantage and benefit increment realization), the use potential of the land is greatly enhanced if there is adequate access.

The forest circulation system is designed to move people and renewable resources within and out of the forest. This system is linked up at various points with the external circulation system. These extraneous systems provide linkages between the forest and other forests and other related land areas, as well as with centers of social and economic activity which impact upon and influence decisions and activities which take place within the forest area.

Comprehensive forest land resource planning, which includes the transportation element, should embrace a considerably more extensive region that the forest area under agency administration. This suggests a regional overview, the dimensions of which are definable by the extent of the physical, social, economic, and institutional influences or externalities exerted by the forest on the region. In many cases, this may be a considerable area and requires the forest planning process to be interactive with a number of simultaneous planning processes at the same time.

Consider the transportation element. Decisions to modify the circulation system within a forest which is heavily utilized as a regional recreational area will no doubt have an impact on travel patterns, traffic flow, and recreational behavior within that region. Conversely decisions by a state or county to widen, repave, or build a new highway to or through a section of a forest area or to allow certain land uses adjacent to the forest boundary will have a significant bearing on the use and impact the forest resource must withstand.

Obviously, the forest resource planner and decision-maker cannot close his eyes to the importance of being associated with the regional planning process, as they often hold implications for all levels of forest planning. This is particularly true when attempting to integrate forest transportation planning with other similar kinds of planning and decision-making which complement the programming of forest land resource management activities.

Thus forest transportation planning and implementation strategies should be sensitive to extraneous influences and considerations.

This relationship in terms of a conceptual forest transportation planning situation is illustrated in Figure 4. Let us assume this is a typical national forest area. The area is managed under the multiple use concept. Outdoor recreation can take place throughout the forest in a variety of ways. Various levels of aesthetic quality pervade the forest. A variety of internal transportation links connect management units within the forest.

To continue, let us designate an area, which because of its unique scenic and resource features, is particularly suited for special management as a featured recreational unit. The relationship of such an area to the entire forest is illustrated in Figure 5. Further, let us decide that this area will have limited ingress and egress and therefore will be a single purpose use area similar in nature to a designated park area.

The recreational area can be further subdivided into three sub-zones, these being high, medium, and low density use accommodation areas. These designations are made on the basis of the ecological resource analysis which led to determinations of impact accommodation with minimal site deterioration. Management plans have been made to accommodate the three levels of use.

Circulation patterns within the area are designed to maximize the recreational experience in terms of the unique characteristics and sensitivities of the resource base. The link system would include trails and roads. Some areas have been designated as open for use of private autos, while others are restricted to only vehicles such as buses. The site is to be linked to the forest road system and to the regional circulation network.

What kinds of situations brought these determinations about? Actually, they can be attributed to a host of factors and influences. Of importance is that the plan has been followed by the policies deemed necessary to effectuate implementation. This process may or may not have considered users and regional citizens points of view. It should. Further, it should be compatible with national and regional transportation planning goals such as energy conservation and environmental quality enhancement.

Figure 4

Conceptual Forest Transportation Planning Situations

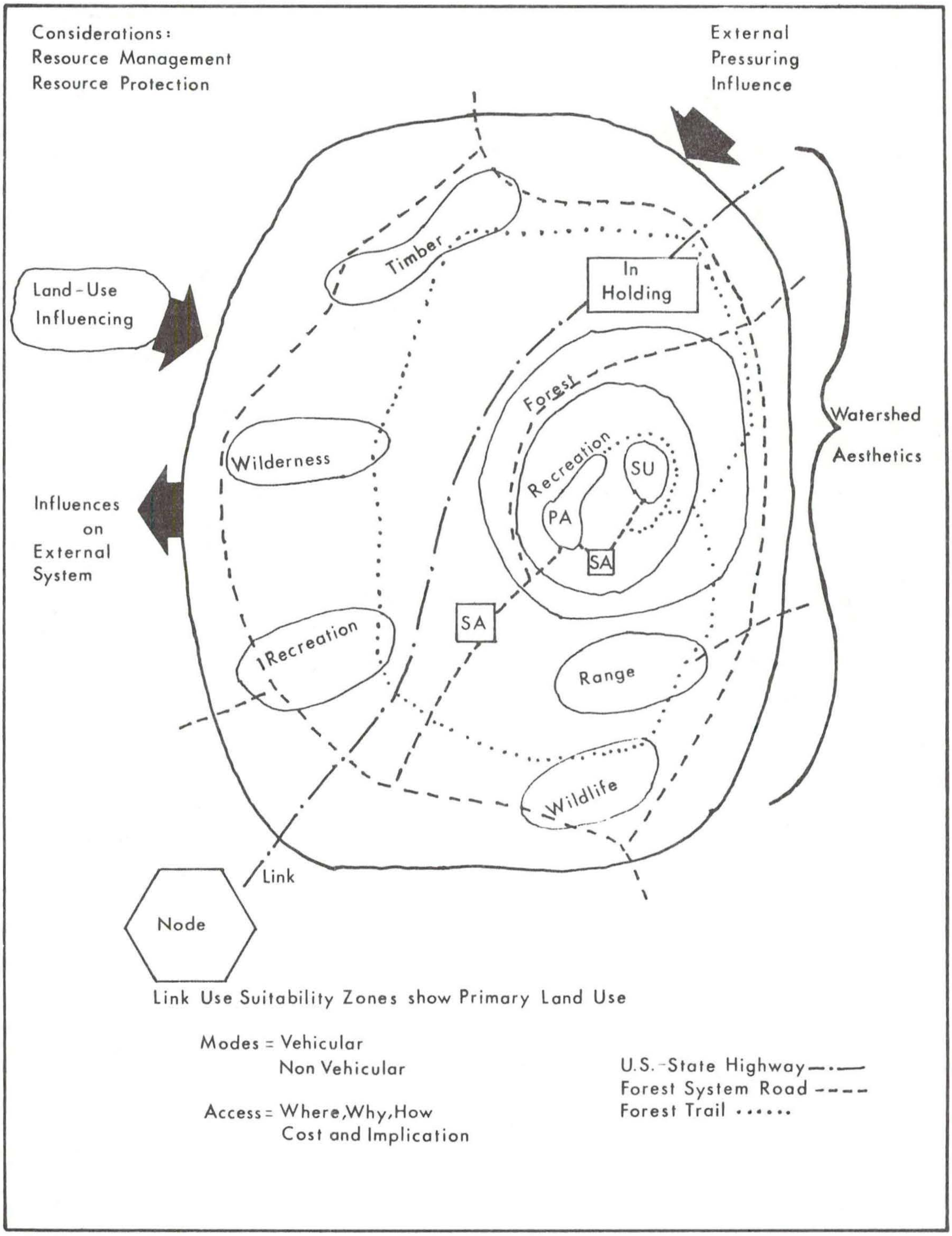
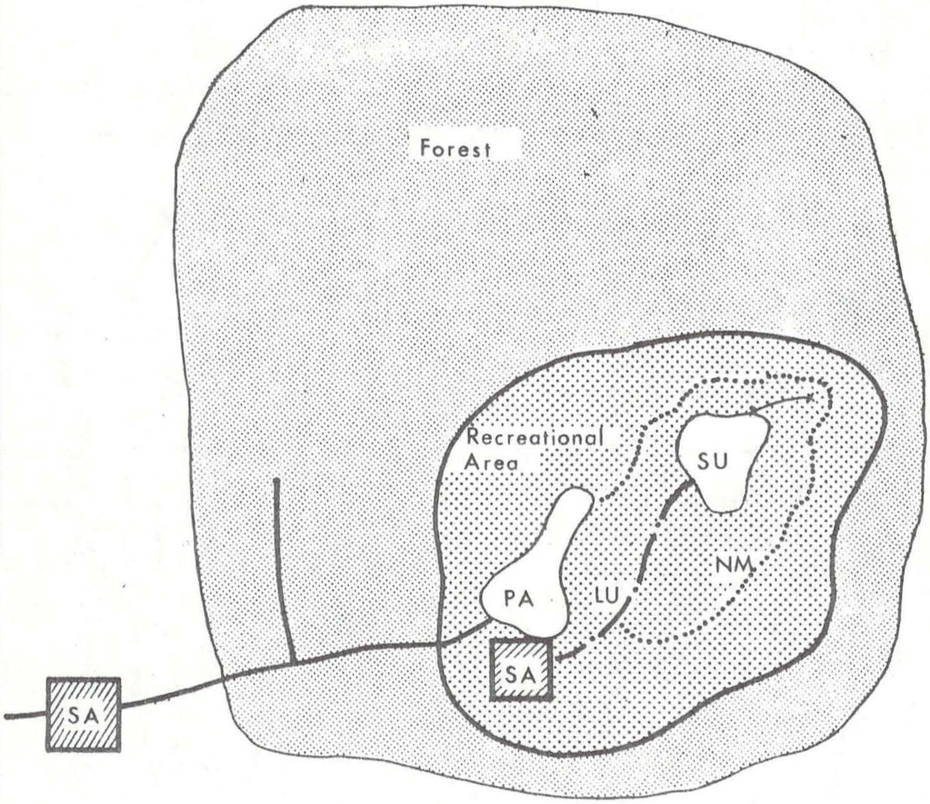


FIGURE 5

Types of Forest Recreational Circulation Systems



SA: Staging Area – Shift from personal conveyance to mass conveyance

LU: Limited Use – No personal conveyance allowed – mass conveyance only

NM: Non Mechanized – Foot or animal only

SU: Specialized Use – Mode designed for specific area and situation

An important consideration at this point is the selection of transportation options. If the link location is fixed, the link type and mode may still be variable. If no links exist then the appropriate location and type of link can be planned. This process takes into account economic, environmental and policy considerations. From an overall management point of view, is is desirable to eventually move to a single option system, particularly when the opportunity to use a second mode would work counter to the purpose of the desired mode. An example of this is a situation where bus transportation is the preferred mode over an existing link. If, however, both bus and auto travel is permitted it becomes difficult to make the shift from auto to bus travel.

A final consideration in any such situation is the linkage between the recreational circulation system and the regional network. Users may arrive at major connection nodes by other forms of mass conveyance such as air or train. They may be transported from this node to the recreational area by bus. Others may drive personal autos to staging areas and transfer to mass conveyance units for movement within the recreational area. At each transfer point, the mode changes.

This kind of system does not necessarily have to rely on mass conveyance vehicles. Given the state of transportation technology, it may be that long distance visitors travel to major staging nodes by mass conveyance then shift to small electric vehicles for maximum freedom of choice among various recreational sites within a large diverse recreational region. In such a situation, which is similar to what we experience with the private auto, recreational facilities in a forest region could be spread out over a larger area and located on most links within the area. This would still result in problems of wildlife endangerments, aesthetic conflict, traffic conjestion, perhaps noise, extensive visitor management and less control over users. Environmental problems created by the internal combustion engine would be eliminated, however, most other major problems associated with use of the personal conveyance systems would no doubt continue.

The formulation of planning strategies and policies to cope with these kinds of situations is by no means an easy matter. Aside from the circulation element, the comprehensive land resource inventory, analysis, and planning design synthesis requires a considerable amount of time and effort. A

key consideration must be what is expected of the transportation system in terms of the comprehensive forest recource management program.

Returning to the recreation area example, it is important to know the kinds of recreational experiences and levels of quality being sought in developing the management plan. In short, this means articulating the expectations in terms of the resource performance under various levels of use and assessing how the resource will receive and respond to the expected use impact. This then must be correlated with the performance aspects of various transportation modes, always considering economic and social factors.

Forest level transportation system management policies reflect the goals and objectives set forth in the comprehensive plan. These policies determine the course of action to be taken by local forest service personnel with respect to the transportation of resources and people through the forest area. The authority to promulgate transportation policy for a forest area is vested in the Office of the Forest Supervisor. Actual formulation of major policy is three-way procedure involving the district, the forest supervisor, and the regional forester. Input comes from staff, citizens, local communities, counties, states and other federal agencies. In many cases, drastic national or state policy changes involve corresponding readjustments in the transportation plans and policies of other governmental units. This underscores the need for comprehensive forest planning to be a viable partner in regional planning activities.

The major types of forest transportation policies involve six areas of concern. These are:

1. Location, development, expansion, or removal of links.
2. Restrictions of the use of certain modes over specific links.
3. Requirements for the operation of certain vehicles on specific forest links.
4. Permits for the construction and operation of specific systems such as tramways, chairlifts, etc.
5. Cooperative agreements with other public agencies and private companies to provide modes for service within forest areas as well as linking forest areas with major staging areas. This includes linkages with other forms of transportation such as air and rail.
6. Regulations governing the areas within a forest where certain kinds of equipment can be used and the conditions governing their use.

The forest transportation planning framework should include all of the factors discussed in this chapter. With the present concern over future supplies of energy, the allocation of this energy for various uses and the cost of energy, it is reasonable to assume that more definitive national energy and transportation policies will have a definite bearing on the transportation plans and policies of all federal agencies including the Forest Service. The emphasis, at this point, should focus on searching for solutions which are aimed at achieving the objectives of energy conservation, economic efficiency, minimal environmental impact, high functional utility, and compatibility with interconnecting systems.

CHAPTER VII

Characterization of Wildland Transportation

Wildland Transportation

From the standpoint of safety, environmental impact, and visitor enjoyment, some change in the primary mode used for wildland recreational travel should be considered. In 1971 almost one half of the fatalities in the national parks resulted from private automobiles. (59) Recreational Equipment Incorporated (REI) and Kelty Mountaineering Company, two of the largest suppliers of outdoor camping equipment have taken stands to reduce impact on wildland areas by proposing mass transportation to recreational areas and issuing "Non-trip suggestions" to customers, in an effort to reduce the number of private autos going to recreational areas. (60, 61) Complaints about noise, air pollution, crowding, hours of mobility, and energy consumption, to cite a few, are the most widely used arguments against the use of the private auto in the wildland areas. (61, 62, 63, 64, and 24)

The wildland areas of the United States that could benefit from new approaches to recreational passenger transportation are selected national parks, national forests and other well used public recreational lands. These are the places outside of urban areas that potentially receive the level of use needed to economically sustain mass conveyance systems. Visitation in the national park system, for example, has risen from 61 million visitor days in 1956 to 103 million in 1966; with the estimated 1976 visitation expected to be 300 million. (6) These masses have brought urban conjection and pollution to national parks in the form of traffic jams, exhaust fumes, roadside litter, and noise. (65) An alternative transportation system may alleviate some of these distracting products of unlimited private automobile use in wildland recreational areas.

National Park Transportation

It has been suggested that the principle management problem in recreational areas is not people, but the private automobile. (7) The National Park Service has begun to modify its basic management policy and exclude private automobiles from certain critical areas in several heavily visited

parks. Public transportation facilities, such as shuttle buses and tramways have transported more people, provided more effective resource protection and enhanced the quality of the visitor experience in certain heavily used national parks. (65) Additionally, they provide opportunities to interpret park values in a more meaningful manner. This has been accomplished with less impact on fragile resources (66) and has enhanced the visitor's total recreational experience. (67)

The National Park Service budgeted $2.4 million to operate mass transit systems at Yosemite, Everglades, Mount McKinley and Grand Canyon National Parks in 1974. This may be an indication of future trends, and of the importance placed on alternative transportation systems. (68)

National Forest Transportation

The apparent demands for mass transportation in the national forests differ somewhat from those of urban areas and the national parks. Most national forests cover large areas and have only a few heavily traveled recreational roads. The Forest Service multiple use policy often demands use of recreational routes for other types of transportation. Researchers at the Institute of Transportation and Traffic Engineering at the University of California have developed techniques to analyze transportation systems within the framework of resource management planning for national forests. They have developed travel-demand and network analysis models, and procedures for data collection and management. These methods take into account recreational travel as well as non-recreational travel. (69)

Transportation planning for the national forests has to be concerned with environmental implications. Use of national forests does not imply degradation of the resource. Environmental problems of transportation for natural resource development and use depend on the type of "cargo" transported, the mode used for transport, the natural conditions of the location, and the economic, social, and commercial circumstances of the region. (70)

A recent area of critical concern that must be taken into account in transportation planning is the energy requirement of the total transportation structure relating to non-emergency travel. High prices for gasoline are already beginning to have noticeable effect on recreational travel. It is still too early to accurately predict the

exact effect that the energy shortage will have on national forest visitation, but indications are that mass transit to select recreation areas may become a reality in the not too distant future, and public transportation at such areas will be in demand. (71, 60)

It would probably be safe to state that no wildland circulation system is perfect. But as indicated previously, comprehensive transportation planning will most often yield the best results. However, this type of planning rests on the analysis and synthesis of large amounts of data pertaining to both the site and the potential user.

Most of the current comprehensive planning exploring alternatives to the private auto for moving people in wildland areas has been in response to problems of severe overcrowding and exhaust pollution. Few planning responses to articulated problems suggest simply limiting the number of people that will be allowed into an area, irrespective of the mode used for transportation to the area. Sabino Canyon in the Coronado National Forest (see Appendix A) is a good example of a recreational area where visitor numbers have been limited by the number of parking spaces available in the Canyon.

Methods of reducing vehicle density that have been successful, in terms of moving the same number of people within the area, involve the introduction of vehicles that carry more people per trip than the private automobile. This type of approach also has the potential to reduce most of the negative impacts associated with the automobile in proportion to the number of automobiles replaced by the vehicle. Larger vehicles or more trips will enable more people to use an area.

Noise, air, water pollution, and impairment of aesthetic values are some of the more readily noticable negative impacts associated with the private automobile in wildland settings. Technology is available to reduce most of these impacts but the costs may be prohibitive. (72) Conventional internal combustion engines can be modified to other fuel sources such as propane or liquified natural gas to reduce air pollutant emissions. (24) Add on equipment to reduce negative impacts has been criticized because of the added weight, costs, and unplanned impacts. The catalytic converter installed on 1975 model passenger cars has been criticized for producing certain acids and for having high operating temperatures. Although the catalytic converters are supposed to operate at temperatures in the 600-900°F range,

it has been estimated that during certain periods the converter's temperature can be enough higher to create a potential wildfire hazard. (73) The catalytic converter may turn out to be a good example of piecemeal planning where in trying to solve one problem, other problems are created.

Problem Formulation

If the public conveyance of people within a wildland recreation area is a viable solution, the planners must adequately formulate and state the problem. In an address to the American Automobile Association, Joseph McKenna called rapid transit a solution in search of a problem. (74) Speaking primarily about subway systems, McKenna stated that most American cities have none of the conditions necessary to justify mass transit systems. These conditions are high density employment complexes, high density residential areas, and clearly defined corridors between the two. Further, he stated that public transit would not turn people away from using private automobiles because it is slower and more expensive. If public transit cannot turn people away from private automobiles then it will not contribute to reducing pollution or the acreage in pavement.

In a wildland setting the problem is much more difficult to formulate. The three conditions McKenna proposed for justifying the use of mass conveyance systems do not apply, and specific problem areas such as high levels of pollution and excessive paving of the landscape are not primary issues. Wildland planners have been presented with somewhat more ambiguous statements of the problem such as "too many cars," "degredation of aesthetic quality" and so on. Wildland managers are often charged with preserving and protecting the environment so that the public can derive numerous recreational benefits from it. The wildland environment cannot be protected in a pristine conditions and be accessable too, without certain trade-offs, such as massive economic expenditures and considerable opportunity costs to society. These expenditures must be balanced against expected benefits and long-term impacts. Congress has stated in the Declaration of Purpose for the 1966 Act which established the Department of Transportation that:

> "Transportation policies should be developed which would provide fast, safe, efficient, and convenient transportation at the lowest cost that is consistent with the general welfare, the economic growth, the stability, and the security of the nation and that is consistent with other national objectives, including the efficient

> utilization and conservation of the nation's resources and the preservation of its natural beauty and historic sites. (75)

So far "a complete and integrated national transportation policy" has not been promulgated. (75) If there has not yet developed a workable national transportation policy it is reasonable to assume that formulation of a national transportation policy for wildland recreation areas will be of high national priority for some time.

The National Recreation Access Study completed in 1975 speaks to this point in one if its forumlated goal statements: "Priority should be given to policies which seek to improve recreational access without creating the necessity of establishing significant new federal programs, agencies, or funding requirements." (16) Other formulated goal statements concerned conservation of the nation's energy resources, improvement of access to areas close to major metropolitan regions, consideration of those persons who have limited personal mobility due to factors beyond their control, preservation of environmental quality and conservation of the nation's recreational resources.

Carrying Capacity

In considering the transportation needs of a wildland recreation resource the question of what constitutes the appropriate level of use must be considered. Resource management agencies are charged with the conflicting challenges of providing the land base for recreational activities as well as of preserving that base for future generations. The land manager provides the resource for public use, but should also prevent over-use from occurring. This, according to Sidney S. Frissell, (76) "involves the determination of an area's carrying capacity and the initiation to land use controls." David Lime and George Stankey (77) define recreational carrying capacity under the assumption:

> That the principal goal of recreation management is to maximize user satisfaction consistent with certain administrative, budgetary and resource constraints. The recreational carrying capacity is the character of use that can be supported over a specified time by an area developed at a certain level without causing excessive damage to either the physical environment or the experience of the visitor. Thus capacity is a multidimensional and dynamic concept capable of manipulation by the manager consistent with administrative, budgetary, and resource constraints.

Two different considerations are involved in the determination of a recreation area's carrying capacity. Physical capacity normally refers to the level of use that the site can withstand without serious damage while psychological, or social carrying capacity refers to the maximum number of people that can utilize the resource over a specified time period while engaged in some activity without diminishing the users "satisfactory experience." Lime and Stankey point out that, due to the complex nature of the concept, there is no single absolute value for an area's recreational carrying capacity.

Some transportation systems as activities themselves fit, are absorbed, or are integrated into the natural environment better than others. Albert Melcher (78) contrasts the possible differences of a low geometry two-lane highway and a four-lane highway. The larger roadway may exceed both the natural and scenic carrying capacity. This is primarily because of the differences in quantity of eco-system alteration caused by construction and operation of the larger road. Melcher also expresses the idea that the design capacity of the transportation linkage may overload a recreational area's capacity to absorb automobiles.

The concept of carrying capacity is important in the transportation planning process because it gives the planner an indication of the volume that the transportation system can and should be expected to assimilate. The capacities of the system and the area should be matched as closely as possible to prevent overloading of either. The number of visitors permitted to be attracted to an area provide clues to the planner which can be used in selecting the appropriate conveyance alternative to fit the comprehensive management objectives for the area.

The transportation system can effectively be used as a managerial tool to limit, maintain, or overload a specific area's capacity to absorb activities. Various forecasting techniques in use and under development plus past experiences with similar situation can be used to facilitate the design of an appropriate transportation system.

Alternatives to the Automobile

The old question of "which came first: the chicken or the egg" seems to be quite parallel to the question facing wildland area managers in general

and the National Park Service in particular: "What is the problem: too many people or too many cars?"

George B. Hartzog, Jr., (79) former Director of the National Park Service, responded to the problem of overcrowding in the parks before it had reached the critical stage. Mr. Hartzog clarified this statement by saying that in some parks, the overwhelming amount of paraphenalia that people bring with them, including automobiles, campers and so on is becoming a critical concern. Instead of limiting the number of people allowed in parks, an approach would be to limit automobile use, and provide alternative forms of transportation. In 1970, the East end of the Yosemite Valley road system was closed and a free shuttle bus replaced the automobile. According to Hartzog, this action "made a great deal of difference in the quality of the visitor experience there, and it has had tremendous public acceptance." (79) "Gradual reduction of traffic and eventual elimination of most visitor vehicles is a basic goal in the search of better ways to manage the national parks." (80)

Nicholas Pole, (24) the Director of Cambridge University Transport Research Project, points out that the problem of cars in the parks is not limited to the United States. One of Pole's concerns is the preservation of the right of noncar-owning families to have access to the countryside, since barely half of Britain's households own or have use of a car. Yet cars account for 75% of all recreational travel in Britain and if Pole is right, the natural beauty of the British National Parks is being sacrificed for the convenience of the pleasure motorist. Pole states that the "..... long term concern is that the national parks be preserved for the benefit of all by drastically limiting the role of the car in national parks." (24)

If too many cars is truly the problem, then several alternatives are available. The Conservation Foundation (81) recommended in 1972 that since it is not feasible to ban private automobiles from the national parks now, that a moratorium be placed on construction of automobile support facilities while a study is made of private automobile policies and alternatives to intrapark transportation. The report concedes that no one mode of transport will meet the needs of all areas; "... where automobile road beds already exist, every effort should be expended to design a system which makes use

of them before alternative facilities are constructed; in new areas without roads we believe rail or other forms of transit might prove preferable to roads if mechanized transport is needed at all." (81) It appears that by limiting car numbers in an area, it may be possible to increase visitor enjoyment, or increase the number of visitors that can use a limited area.

Pole (24) points out that along with the need for alternative transportation at the beauty spots themselves, there is a need for alternative transportation service between the recreation areas and the main population centers. The energy crisis may be the most important factor stimulating public demand for such a total transportation system from the cities to and within the parks. Pole's summary in 1973 seems particularly comprehensive:

> "Because of the forthcoming world oil shortage, as well as for reasons of safety, landuse, congestion and amenity, we can no longer rely on the conventional private car as the dominant part of our transport system. It is extremely shortsighted to plan recreational facilities in our national parks almost exclusively for the benefit of the car owner. We therefore urge the government to move towards a ban on private cars in well-known beauty spots and severe limitations on cars in the national parks as a whole, providing attractive alternative transport at such sites and for access to them. These measures will both enhance the visitor's enjoyment towards a badly needed change in our social attitude to the car." (24)

Mode Selection Problems

Selection among alternative transportation modes is an extremely complex problem because of the large number of alternatives available to the decision maker. There is a limited number of general mode types available when all modes are categorized by some characteristic, whether it be the type propulsion system used, the type activity the mode is usable for, or so on. Within each category there are secondary characteristics or modifications of characteristics that can complicate the selection process even further.

Take the simplified hypothetical case of Christopher Columbus who, in the 1400's might have been involved in the selection of a mode or more probably the vehicle to be used in discovering a better route to India. The initial selection of a feasible mode would not have been too difficult since practical alternatives were limited to ocean going ships. Within the broad category we will assume that cost was not the limiting factor. The methodology used was probably simple; find sailing ships that were available and that could be fitted for an exploratory voyage that were capable of carrying a

crew of explorers. Availability was the primary consideration and currently used parameters such as cost effectiveness, comfort, speed, noise output and so on were not major considerations because there was little difference between the available choices. Columbus probably could have required modifications, but the choice of viable modifications available was relatively limited.

After five-hundred years of technological advances, the selection process would have been much more complex and important. To put men on the moon, there evolved a special type vehicle just for the accomplishment of one set of goals. No vehicles were in existing use that could physically make the trip. Again cost was not a major parameter in mode selection. Instead of having a choice of existing modes (even such limited choice as Columbus had in the 1400's) the engineers had to custom build a highly modified adaptation of the existing concept of the rocket.

There are few instances in the modern world where initial cost does not enter into the selection of a special purpose transportation system. The decision making process probably begins with an unconscious elimination of ideas that seem completely without potential. The rationale for this statement is that planners will eliminate or not even think of alternatives that are absurd, and channel their efforts towards evaluation of only feasible alternatives. With existing transportation technology the planner must first state some type of problem that needs a solution and then access the available technology and reject the nonapplicable alternatives. In most planning situations there is, at some point, the very imposing constraint of cost. There will always be a finite amount of money that can be spent to arrive at an acceptable solution. Therefore, one approach to transportation mode selection would be the initial categorization of alternatives by their expected cost range. Under this category, there would be subcategories to be used in narrowing the list down to a limited number of system types that could be used to solve the existing problem.

The primary problem with this methodology is assigning the cost range to the individual modes or mode types that will accurately reflect the total system costs under different application situations. Most transportation systems perform most effectively when they have been tailored to the specific application.

Another approach to mode selection would be to initially categorize alternatives by range of their potential success in meeting the application classification, then utilize subclassifications to narrow the selection to specific mode types that have potential for problem solution with or without modifications. It is important to the selection process that alternatives be stated and then comparatively evaluated. Without listing, and evaluating alternatives at a point in the process the best alternative is rarely even surfaced, let alone recognized and selected. The decision-maker must have some type of evaluation of existing alternatives available either to him or to those who are charged with the design of a system to meet the stated need. Using this approach to substantiate the need for presentations of existing alternatives, it must also be made clear that no listing can accurately present all alternatives available within any type of categorization. The continued development and improvement of various transportation mode concepts will outdate any type listing.

CHAPTER VIII
Synthesis - The Link-Vehicle Concept

Wildland transportation planning is usually done by the agency which is responsible for the resource base. More often than not, the planning effort has been suggested or brought about by some individual or group that is concerned with one specific use of the existing or proposed system. Previously, identification of potential users was mentioned as an important element of the transportation planning process. To expand this approach, once the users or beneficiaries of the system have been identified, their transportation goals and objectives should be identified.

Group Identification

Initially, all transportation systems on public land affect and impact on a minimum of four different groups of people. The groups can be independently categorized as recognizable entities at some point in time. While it is recognized that a person may fit into each category, for the sake of simplicity the following categories may be identified: Administrator, Operator, User, and Non-User.

The operator category is composed of the group of people directly responsible for the system; this group is the one concerned with maintenance, operational safety, law enforcement, and so on. The user category is the group of people who actually depend upon the system for transportation. This group may be broken into subgroups to properly evaluate their need for different travel related activities. The non-user is a category to characterize the "public" who do not actually utilize the system, but pay taxes and are concerned with the manner in which the resource is managed. The administrator category is defined as the group that is entrusted with managing the resource. This group is the one which is directly accountable to the public and which operates within the political frame of public land administration.

Goals and Objectives

Transportation goals and objectives can be identified for each group in the transportation system. Figure 6 presents an example of how this approach could be used for a hypothetical transportation system. The aggregation of data presented in Figure 6 will probably be the same to respond to a general

Figure 6

Transportation Goals & Objectives

	Operator	User	Non-User	F.S.
Transportation goals	Improve ease of operation	Increase accessability to opportunities	Increase/Concerve personal resources	Allocate costs and benefits equitably
	Increase cost efficiency	Improve quality of travel	Minimize disruptions enhance area	Enhance/Conserve natural resources
		Conserve Personal Resources	Conserve Public Resources	Accommodate multiple use in orderly manual
				Enhance environmental quality
Corresponding Objectives	Improve Working Conditions	Decrease travel time	Enhance property values	Assign system in relationship to benefits received & ability to pay
	Minimize labor/consumer complaints	Decrease travel costs	Increase exposore/accessibility to markets	Minimize resource degradation
	Improve management	Improve other system characteristics (non time, non cost)	Minimize construction disruptions	Provide transportation to encourage use in accordance with plans
	Improve safety, security		Minimize permanent disruptions	Enhance air-water-land, aesthetic and recreational quality
	Increase utilization		Improve areas quality	

statement for all areas: "Improve the system at minimal economic and environmental costs, so that it will be responsive to the needs of all concerned." This is a laudable goal for any transportation planner, however the identification of the various elements that go into the response to such a statement set the stage for developing the appropriate planning framework.

In most of the existing mechanized wildland transportation systems the road, trail, or path on which user supplied vehicles operate has been developed. The links may have been planned specifically for general circulation or they may have resulted from the need to remove or manage a resource such as timber. The links or routes may be high standard, well maintained highways, or simply a pair of well-worn tracks that people use as a means of access to a remote recreation area, but regardless of their origin or standard, some will be well-suited to their present use and others will not.

The primary users of these routes are the people who are traveling in personal vehicles. These vehicles can be classified as having some number of rubber tires that support the vehicles. The vehicles for the most part are multipurpose, although there are some highly specialized vehicles designed to meet special user/owner needs. The important feature of these vehicles is that the purchase price and operating costs are born by the owner-operator, and they are used to transport the user and his recreation equipment (which may include a number of auxiliary recreational vehicles) from his residence to the wildland area.

Typical recreation trips can be broken into several components, however those which will be considered here are: (1) from residence to area, (2) within the area boundaries, and (3) from the area to next destination. The existing situation in most wildland areas is that some number of users arrive at the perimeter of the area in their personal vehicles and continue on until they reach their destination. (Some people may only be traveling through the area enroute to another destination.) The point at which the users stop may be entirely their choice, an area in proximity to something they wish to see, or a place they wish to stay for several days. In many areas wildland users also have the choice of stopping where others stop, or at an isolated place where they can enjoy the solitude of nature interrupted only by their presence.

The problem, in many instances, is that there are too many of these users competing for a very limited resource. Part of this problem stems from the spatial requirements imposed by an increasing number of vehicles. Large areas designated for parking, for example, detract from the aesthetic quality of many recreation areas.

Link-Vehicle Concept

Figure 7 shows the range of all transportation alternatives available to planners. Utilization of this method of categorization can aid in identifying the existing system in a framework that can lead to certain assumptions for planning and selection (or modification) of the system within the range of options available.

(1) A "Link" will be thought of as the route or path used to get from one point to the other. In recreation transportation the "points" may be abstract, and length of the link between two points may be measured in units such as travel time that sometimes have no relationship to the actual physical distance between the points. The established approach in use where links and nodes (the intersections of links) are used to analyze existing transportation systems or networks is a special case of this more general approach. Link also must connotate controls or regulations placed on the user.

(2) A "not supplied link" is the route used by the public moving about in the recreational area. This would quantify the path used by horseback riders, cross-country skiers, operators of all terrain vehicles and the like who utilize some form of transportation as the primary recreational experience. This situation occurs when: no formal link is necessary for travel; the entire area is a "link," (i.e., lake); or the user defines the link (i.e., snowmobiler).

(3) A "supplied link" is the established road, trail, track or path recognizable to the public as the route to be used in getting from one point to another.

(4) The "Link not supplied, vehicle not supplied" (LNVN) classification would apply to the recreationist who is on his own to travel into an unmarked area. The user would provide his own vehicle whether it be horse, snowmobile, or whatever, to go wherever he wants.

Figure 7

Link-Vehicle Transportation System Classification Concept

Link not supplied Vehicle not supplied	Link not supplied Vehicle supplied	Link supplied Vehicle not supplied	Link supplied Vehicle supplied
LNVN	LNVS	LSVN	LSVS

TRANSPORTATION SYSTEM

Link(1) Not Supplied(2)*		Link(1) Supplied (3)*	
Vehicle not supplied* (4)	Vehicle supplied* (5)	Vehicle not supplied* (6)	Vehicle supplied* (7)

*"Supplied" or "Not supplied" by public agency.

(5) "Link not supplied, vehicle supplied" (LNVS) classification would be applicable primarily when a concessionaire provides a vehicle including snow shoes cross-country skies, trail bikes, etc.) to the recreationist who uses it for "Off road" travel.

(6) "Link supplied, vehicle not supplied" (LSVN) this is the classification that fits most existing situations. The road, trail or other link exists that when compatible to the user provided vehicle, enables the user to move about within an area. One significant point here is that if the link is similar to the links used to get from his residence to the area, the user's vehicle is the only vehicle needed for the entire trip.

(7) The "Link supplied, vehicle supplied" (LSVS) classification would be applicable when both the vehicle and the route are provided to the individual or passenger. Most of the mass transportation systems would fit this category. A train is a good example, the train is the provided vehicle and the track is the provided linkage.

The link--vehicle classification concept may be an important method of analyzing transportation alternatives. The "Link Mode" network concept has been used for network analysis to determine shortest routes for areas where there is more than one possible access route. Simply stated the existing link-node concept is used for analysis of alternative modifications to existing network. (82) The link-vehicle concept would be used to classify options whereby analysis of the classification would indirectly yield comparative data.

Obvious comparisons can be made immediately from Figure 8. Economically the options can be ordered from least to most expensive: (1) link not provided, vehicle not provided (LNVN) and (2) link provided, vehicle provided (LSVS). Environmentally the options may be reversed when speaking of degradation.

Several assumptions are basic for the application of the Link-Vehicle Analysis concept. Table 2 presents one set of assumptions, most of which are self-explanatory.

Mode Shift

The planning of internal transportation systems in a wildland area necessitates an evaluation of the interchange between the internal and

Figure 8

Link Vehicle Comparisons

Increased

Complexity of System

LNVN LNVS LSVN LSVS

Cost of System

Increased

TABLE 2

Transportation System

1. Link and vehicle must be compatible.

2. Link and vehicle make up the subsystems.

3. Node is the intersection of links or one end point of links.

4. Important nodes occur when there is a shift from one L-V system to another.

5. Subsystem capacities must be comparable to capacity of nodes to distribute.

6. Destinations of travel may be definable, or undefinable.

7. Resource and transportation planning will occur simultaneously.

8. Both movable and non-movable resources are involved.

9. More than one vehicle is capable of operation on any one link.

10. To effect change in one subsystem, the manager chooses between the three alternative L-V combinations or modify the existing combination.

11. To change from the existing subsystem to an alternative necessitates study of entire system, especially adjacent subsystems.

12. To change from one type subsystem to another at an important node necessitates consideration of vehicle used to arrive at the important node.

external system. The interchange will occur at some node that is common to both systems. Using the link-vehicle approach there will be change in either type of vehicle (or both) at the node. The two (for simplicity it will be assumed that only two different link-vehicle combinations will occur at one node) different type systems that share a node generate some information about the node.

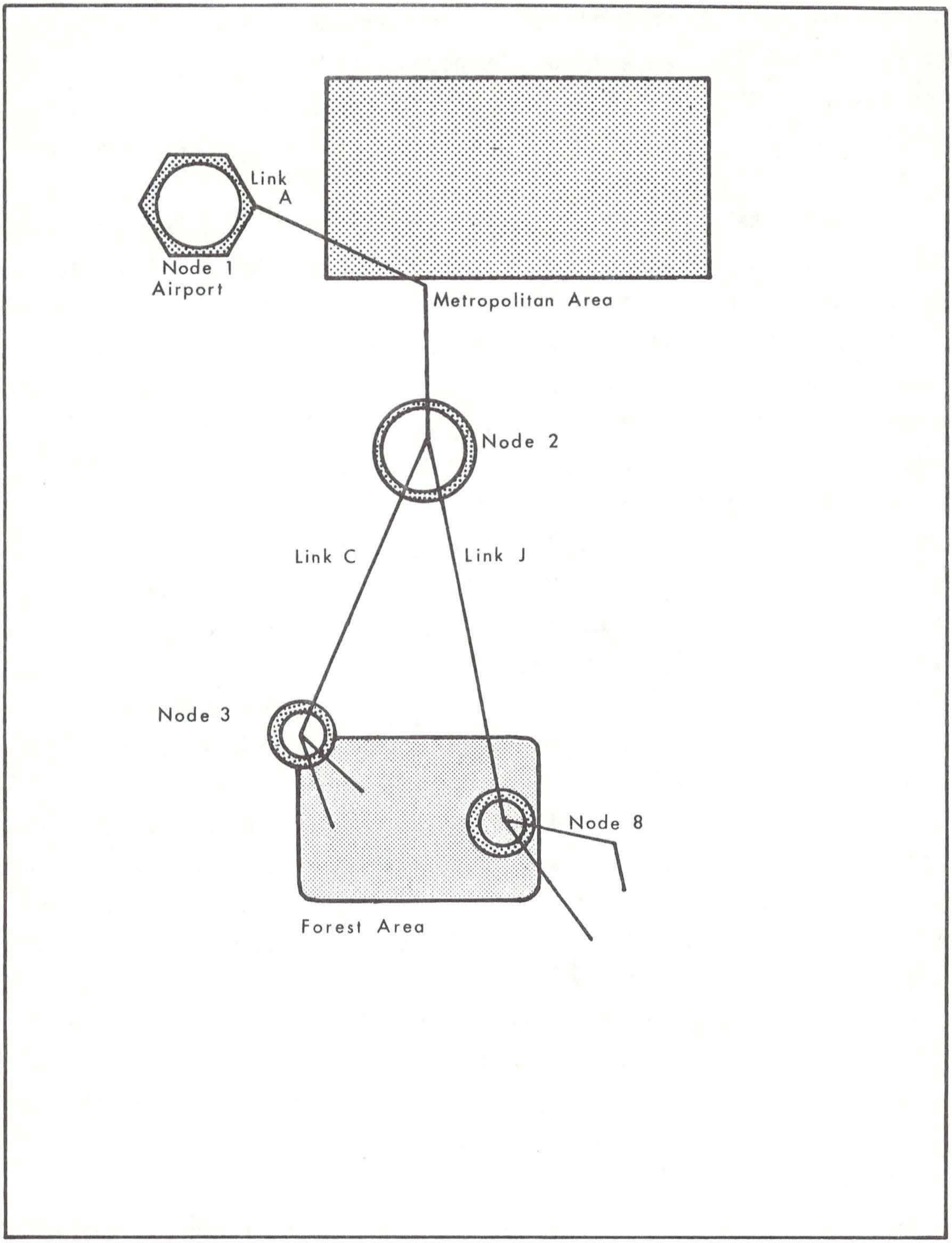
For example, take a shift from private cars used in the external system to buses used in an internal system. An LSVN to LSVS node would mandate a storage or parking area for the cars and a storage/maintenance area for the buses. Information required for planning this situation would include: (1) expected rate of cars arriving and departing the area, (2) average number of occupants per car, (3) time user wants to spend in area, (for terminal facility sizing and bus scheduling), (4) seasonal fluctuations, (6) activity (ies) user would like to participate in, at the node and so on.

This type system forecloses the options now in existance in a total LSVN system where the user has wide variation in choice of personal gear. Trailer camping would be limited to the node as would most activities that require equipment that is not readily transportable.

The internal system has to be operational when only one user enters the area or the user is denied the opportunity to use the area to capitalize on his application of the Link-Vehicle analysis method. The total area transportation system has been broken down into these component parts. The Link-Mode concept previously mentioned identifies the various links and nodes by size, type and so on. The Link-Vehicle concept identifies the type of system in operation on each link. Referring to Figure 9, Node 3 can grant access to the forest area only by link J or link C. A public bus system (LSVS) might move people from the airport (Node 1) to the area via links A and C, but if the bus cannot operate inside the area the people have to walk from Node 3. Conversely if a bus system operates in the forest area exclusively and a LSVN system operates between the urban area and recreation area parking will be required at Node 3.

Link J represents a through highway (LSVN) which only grants access via Node 8. If the area has an exclusive LSVS system, access would be denied from Node 8 because if there is no provision for parking at the node. In this

Figure 9
Link-Vehicle Shift



case, the LSVS system would probably have to be subsidized . Regularly scheduled trips have to be made regardless of vehicle occupancy if the system is to be accepted by the public who uses the LSVN system to reach the area. In the contrasting situation of more people arriving by an LSVN system than the capacity of the LSVS system, the overage would have to be turned away.

External fluctuations in factors such as fuel availability and energy costs will effect the LSVN system directly, and effect the LSVS system indirectly. An operational internal LSVS system depends on LSVN external system entirely for passengers. If the trip to the area via an LSVN system becomes too expensive then there may be insufficient passengers to amortize the internal LSVS system costs, which also are energy related.

The Compatibility Matrix, Figure 10, graphically displays certain characteristics of selected link-vehicle combinations. Almost all systems can be operated in the LSVS classification while very few systems would be feasible in the LNVS range. The Compatibility Matrix in conjunction with the Generalized Response Matrix, Figure 11, can be used to make generalizations about a particular system.

If for example major considerations involved with selection of a system are arranged as follows:

(1) Low cost requirements,

(2) high control over uses to prevent adverse impact, and

(3) flexibility to respond to changes in future system demand, then either a LSVN or LNVS system is implied with the LSVN system being more responsive to the goal of preventing environmental impact as was implied in consideration Number 2. The LSVN list of systems on the Compatibility Matrix (Figure 14) lists options that can be further reduced by considering the amount of demand that will be satisfied and the intensity of physical contact with the environment that is desired.

Hypothetical Example of L/V Concept Application

The following example utilizing the Link-Vehicle Concept on a macrolevel, as illustrated in Figure 12, shows hypothetically how the concept could be applied. Sabino Canyon which is used for the hypothetical example is described in Appendix A.

The Forest Service cannot change the entire generator to attractor transportation system on its own, however, the city and county have not entirely

Figure 10

Compatibility Matrix

	LSVN	LSVS	LNVN	LNVS
Private Car	Y	N	Y^4	N
Bus Y	Y^5	Y	Y^4	N^6
ACU Y	Y^5	Y	Y^5	N^6
Train	N	Y	N	N
Aerial Tram	N	Y	N	N
Horse	Y	Y	Y	Y
Bicycle	Y	Y	N	N
Plane	Y	Y	N	N
Helicopter	Y	Y	Y^5	Y

Y-Yes N-No

1. Link should be compatible to user's vehicle.
2. Required mode shift.
3. Special circumstance only.
4. High environmental impact.
5. Relying on owner supplying this type vehicle.
6. Feasible but impractical.

Figure 11

Generalized Response Matrix

	LSVN	LSVS	LNVN	LNVS
Control over user	medium	high	none	high
Operating costs*	medium	high	low	medium
Initial costs*	medium	high	low	medium
Activity responsive	high	low	low	low
Multiple use response	high	medium	low	low

*Cost as used here does not reflect environmental costs. Environmental costs would vary according to the specific system characteristics so no generalizations are made.

Figure 12

Link Vehicle Macro Analysis Procedure

Do you want to maintain the existing total system? Yes STOP

No

Yes Can the town to area system be changed:

Identify potential staging area in town No

Determine if Link or Vehicle change would accomplish goals--possible that total system

Are adequate staging areas available on site or adjacent to site for system change? (parking) No STOP

Yes

1. Determine Area Capacity.
2. Determine Demand (Quantity & Tape).
3. Evaluate the physical restraints imposed on system by the area.
4. Determine the management objectives that relate.
5. Determine what management activities will make requirements on the system.
6. List the desirable system characteristics relevant to 1-5 and the area management objectives.

discounted the possibility of such change. In this case there are two potential macro alternatives, depending on whether or not the town to area system is changed.

Examination of the First Alternative:

Town to area system not changed. Internal change only. An adequate staging area could be constructed at the Sabino Canyon Visitor Center or in close proximity. This would enable the interpretation/education activities opportunities at the center to be greatly increased. The maximum capacity of the visitor center should be assessed in order to relate this to the total number of visitors the bus system would bring to the staging area on each trip.

Evaluation of the present system indicated that the links in the existing Sabino system are adequate for circulation and that the type existing vehicle needs to be evaluated for possible change. Partial elimination of private automobiles in the system would not be feasible because of administrative difficulty in equitably determining which vehicles would be permitted to operate in the system. Bicycles and other non-powered modes (foot, horses, etc.) might be accommodated on the links with further evaluation (safety - interface with alternative mode).

The Sabino area maximum capacity has been calculated to be approximately 2,200 people for day use. (See Appendix A) The average visitor on-site-time has been determined to be three to four hours. At the existing 3.2 people per private automobile arriving at the site from the town, the staging area should accommodate 360 automobiles. The use figures are approximately equal to area capacity so the transportation system should be designed to accommodate area capacity. The staging area and transportation system should accommodate only the area capacity to prevent over use.

Utilizing the existing link, the proposed vehicle should be a conventional tracked or independently controlled vehicle which can operate on a narrow two lane paved surface. Steep curves, fairly steep grades, and narrow passing space and small turning areas are the major site constraints on the vehicle.

The user experience has been evaluated for day use. Permitted activities are hiking, water play, picnicking, horseback riding, bicycling, sun bathing, photography, limited rock climbing, and use of the upper canyon as a staging area for back packing on the trails leading to Mt. Lemmon. Management objectives relating to visitor use are:

1. Improve public safety
2. Provide for the physically limited
3. Minimize visual pollution
4. Maximize environmental interpretation opportunities.

Management functions requiring transportation are:

1. Access to upper Sabino rest room for medium size truck (once a year to pump septic tank) existing link will fulfill this requirement.
2. Access to facilities for maintenance.
3. Litter removal.
4. Fire control activities.
5. Law enforcement and public safety functions.

Desired system characteristics are:

1. Has to operate on existing link; link could be modified if necessary.
2. Link cannot be modified to the extent that a conventional vehicle cannot utilize link for access to upper Sabino rest room.
3. Vehicle(s) should be safe for passengers and area users.
4. Vehicle(s) should be able to move 2,200 people per day.
5. Vehicle(s) should accommodate physically limited.
6. Vehicle(s) should be visually acceptable to area users.
7. Vehicle(s) should produce minimal noise, air pollution, and should not degradate the link or site in other ways.
8. Vehicle(s) should have potential for interpretation.
9. Should accommodate passenger picnicking, backpacking.
10. Should be compatible to hikers, bicycles, horses, etc.
11. Should maximize passenger comfort and convenience.
12. Require minimal on site support.
13. Compatible to existing roads and bridges.
14. Compatible with grades and curves.
15. Maximum travel distance is 2-1/2 miles.
16. Not necessary to protect riders from inclement weather.
17. System should provide maximum interaction between passengers and environment.

Figure 13 is a sample of initial inferences based on these characteristics.

Figure 13
Sample of Initial Inferences

Characteristic #	Inference
4,5,8,9,11	
13,15	Light weight vehicle
1,2,7	Rubber tired
4,6,8,10,17	Slow speed
11	More than one vehicle to system
5,9,16,17	Large easily accessed, perhaps open air passenger compartment
11	Regularly scheduled
12,14	Internally powered
3,10,17	Low noise and fire hazard
15	Short haul vehicle
7,10,11,17	Low pollution vehicle

CHAPTER IX

Transportation Planning Constraints

The transportation planning constraints identified from this research have been grouped into six broad categories: feasibility, political, financial, resource, user, and operational. These categories are not necessarily mutually exclusive and no attempt has been made to order the constraints or the categories.

The purpose of this type listing is to make available to the planner as many of the potential general constraints as possible that may affect the selection of the most appropriate transportation system for a specific area. It is important to stress that this listing is by no means complete. Inherent weaknesses may surface from the use of "complete" planning approaches because each area is unique and has unique problems that planning must be responsive to.

The influence of the constraints should be considered during all three phases in the life of a system. The planning-design phase should be responsive to all constraints. Construction phase planning should be heavily influenced by the natural resource constraints. It is also important to include the resource constraints and operational constraints in the operational phase because of the continuing nature of the spill-over impacts produced during this phase.

This listing should be used as a check list of potential constraints affecting any of proposed alternative transportation systems for an area. Some listings will not be important constraints for a specific area, but may be important to at least consider, while others will be of primary importance in the selection of a system. At this point, the planners can use this listing as a general guide. Phase two of the project will develop a scheme for ordering the more important constraints.

The constraint listing should be regarded as a list of potentially limiting factors the responsible individual within the system has to be aware of. Some of these factors are "fixed", that is, they cannot be easily overcome without extremely large expenditures of time and money. Examples

of fixed constraints would include legislation, certain jurisdictional boundaries and also size. Other limiting factors may be regarded as variable. Various governmental priorities may be quite variable from the planners point of view, as well as such things as availability of labor, experience level preference, and mobility of potential users.

Some of the constraints are absolutely fixed, that is, they could not feasibly be changed and some are extremely variable; they rarely stabilize at one point long enough to be quantified.

The fixed constraints should be identified and listed first in each category for each separate planning effort. Even if they do change, they change discretely and not continuously. Variable constraints will normally change continuously or are capable of such change even if they appear to be discrete. These constraints can be best identified and evaluated by the person they affect. Identification of the planning unit, or management unit if it is different, will be important to keep in mind, because the constraints should be evaluated in terms of their influence at this level.

To summarize, the listing should not be regarded as complete for any transportation project, and unique area constraints should be added. For some areas, the listing will undoubtedly include constraints that are not worthy of consideration and these should be deleted.

Feasibility Constraints

The feasibility constraints deal primarily with the initial determination to install or modify the transportation system for an areas. The administration has the responsibility of allocating resources to fulfill various demands placed on these resources.

In this allocation process, alternative transportation systems can be evaluated by how well they potentially meet the required functions of the ultimate system. The trade-offs of functions are made at this stage in proportion to the importance and values placed on each constraint. A typical constraint listing is as follows:

1. Location and type of demand

2. Enabling legislation, e.g., Organic Act, Multiple Use/ Sustained Yield Act, Renewable Resources Planning Act.
3. Private landholdings and special use permits.
4. Use vs. protection conflict.
5. Public demand vs. responsibility to the public.
6. Special interest group pressure (power).
7. Allocation of resource.
8. Limited resource.
9. Conflicting activity demand.
19. Regional goals.
11. Available technology.
12. Location of user generators.

Political Constraints/Institutional Constraints

The political constraints are normally constraints outside the control of the administrative agency that governs the planning process that influences transportation planning. There are legislative limits to the scope of wildland transportation planning as well as other factors that limit the scope of planning as well as implementation.

Poitical Constraints

1. Required Interactions
   a. Multiple jurisdictions and organizations involved
   b. Conflict with desires of local economy
   c. User demands
      1. Public demands
      2. Special interest group demand
   d. Allocation of resource
      1. Fuel
      2. Recreation
2. Policy
   a. Lack of national transportation policy
   b. Lack of a unified recreation policy
   c. NEPA of 1969
   d. Intergovernmental jurisdictions
      1. National agencies

2. States
3. Bi-state compacts
4. Special (Indian Jurisdictions)
5. County
6. Local

e. Jurisdictional and administrative agreements

3. Interface with area transportation system
   a. Railroads
   b. Automobiles
   c. Public transportation
   d. Trucks
   e. Watercraft
   f. Aircraft
   g. Transportation corridors - pipes - power transmission and communication lines
4. Public resource needs
   a. Transportable
      1. Renewable (timber, water, game)
      2. Non-renewable (minerals)
   b. Non-transportable
      1. Recreation
      2. Aesthetics
5. Energy
   a. Cost and availability
   b. Governmental allocation

Financial Constraints

The financial constraints are probably the most limiting of the factors involved in any planning process. The listing is intended only to serve as a general guide. Once financial resources are known, comprehensive economic analysis and feasibility studies are in order for the selected site and available technical alternatives. Alternatives should be evaluated under the established agency guidelines.

Financial Constraints

1. Finite amount of money

2. Cost effectiveness
    a. Facility cost
        1. Design and construction of facilities and transportation system
        2. Amortization of existing system and facilities
        3. Lost use time during construction
        4. Time value of money
    b. Operating costs
        1. Maintenance
        2. Labor
        3. Insurance (if required)
        4. Support facilities/functions
        5. Fuel
    c. Income requirements
        1. Passenger willingness to pay
        2. Availability of subsidy

Resource Constraints

The listing of Resource Constraints is intended to initially indicate characteristics as well as limitations the system should have to be considered. Missing constraints should be added and all listings be carefully evaluated.

1. Size of area
2. Slope
3. Soil
4. Geology
5. Drainage
6. Vegetation
7. Wildlife
8. Hydrological characteristics - local drainage network
9. Other use priority - watershed
10. Weather patterns
11. Aspect
12. Water quality
13. Air quality
14. Fire potential
15. Aesthetic characteristics

User Constraints

The transportation system is built and operated for the user, therefore, an understanding of user constraints pertaining to the areas and the system is essential. The primary user constraints are demand and time. The first demand listing concerns only the quantity and type demand, generated by users. The type and size of system selected should reflect these characteristics. The time element refers to the available time the user has to spend in the area which should be considered when selecting the system, routes, and schedules.

User Constraints

1. Preferences
   a. Propensity to consume recreation
   b. Variability with time and season
2. Time/travel distance limitations
3. Disposable income
4. Perceived demand for
   a. Safety
   b. Convenience
   c. Aesthetics
   d. Experience level
   e. Conservation - education
   f. Comfort
5. Physical limitations

Operational Constraints

Operational constraints are those factors which determine some of the desired characteristics of the transportation system. It is important to realize that the forest management unit generates many other demands for transportation which this system must adequately and efficiently serve.

Operational Constraints

1. Financial
   a. Lack of consistent user fee policy
   b. Flexibility of federal priorities
2. Use Problems
   a. Vandalism, theft, trash, public safety, drugs, etc.
   b. Varying demand

3. Dynamic Resource
    a. Fire
    b. Flood
    c. Other acts of God
4. Multiple use requirements of area
5. Availability of labor (esp. skilled)
6. Seasonal variations in use

Environmental Impacts

There are certain environmental impacts associated with transportation systems that must be evaluated for each proposal. These impacts must be considered in planning any major transportation project on federal lands as mandated by the National Environmental Policy Act of 1969.

The listing presented here illustrates some of the general areas of concern regarding negative impacts associated with the construction and operation of a transportation system.

The listing of actions affecting the natural resources are potential impacts that should be considered. This list should be used, with appropriate additions and deletions, as an indicator of the cumulative impact the resource will have to absorb from the construction and operation of the system.

Some impacts arising from construction and operation of the transportation system are:

1. Alteration of ground cover (vegetation)
2. Alteration of water quality
3. Alteration of air quality
4. Alterative of drainage patterns
5. Alteration of wildlife habitat
6. Alteration of soil/geology

Construction Activities Potentially Impacting Resources

1. Vegetation removal - surface clearing
2. Burning of vegetative residue
3. Blasting and drilling operations
4. Earth moving operations
5. Construction of structures
6. Well-drilling and fluid removal

7. Dredging
8. Chemical stabilization of soil
9. Dust generation
10. Borrow pits for fill material
11. Vibration
12. Noise
13. Surface paving
14. Seeding and reforestation of area
15. Erosion control
16. Weed and insect control measures for site
17. Spills and leaks of chemical compounds

Impacts on Resources During Operation

1. Chemical deicing
2. Exhaust emissions
3. Explosions - fire
4. Spend lubricants
5. Cooling water discharge
6. Liquid effluent discharge
7. Wildlife stocking - management
8. Landscaping
9. Energy generation
10. Storage areas
11. Introduced barriers
12. Change in local economy
13. Dust generation
14. Vibration
15. Noise generation
16. Spills and leaks of chemical compounds

CHAPTER X

System Design/Specification Methodology

The potentials of alternatives to the personal automobile as the primary mode of transportation in wildland areas necessitates the development of new transportation planning approaches and methodologies. This research team has discovered that potential alternatives within a limited range of general modes are almost unlimited in number. Because of the rapid pace of transportation innovation and the unpredictable nature of such external factors as fuel and energy supplies and pricing structures, a transportation mode design/specification methodology would be quite useful to wildland planners.

The conceptual framework presented here will lead to the design of good alternatives for consideration in mode selection. The actual development and testing of a mode design by specification methodology will be forthcoming in the next phase of this research.

The framework presented here will accommodate the transportation goals and objectives previously discussed as they apply to the four basic groups of people concerned with the characteristics of a wildland transportation system. The link-vehicle concept will be used to analyze the existing system, if any, operating within the area and to project possible consequences of future alternatives. The constraint listing presented in Chapter 8 will be used as a basis for defining the requirements of the planned system.

The framework was conceived as a process operating in a manner that parallels an idealistic job description development process. The designers of the system specification would play the "role" of a personnel manager who is responsible for writing the job description. He must learn the intended function of the position, advertising the vacancy in such a way as to only have to review the best suited candidates, and finally selecting the candidate who can best fill the vacancy.

Hopefully, the first action of the personnel manager will be finding out all he can about the proposed position from the people who requested the search. His next step would be to analyze the working environment with the help of people who have some expertise in the function and requirements of the activities that take place within the environment.

For wildland transportation planning purposes the environment will be the resource base itself and the surrounding area, in light of the development plans for the area. The link-vehicle concept can be used at this point to describe the existing transportation network.

The entities described as categories of people concerned with the transportation system should be identified for their initial input and feedback throughout the process. The User category will be composed of present and potential system users. The Non-users category will be composed of interested citizens who will not have direct contact with the system. The Operator category may be composed of potential concessionaries or other persons who will have direct day-to-day responsibility for the system. This group may have to be proxied at the beginning of the process unless the existing system is such that the members of this group can be identified. The Administrator category is composed of the group which is ultimately responsible for the area's management.

These categories of people, when identified and put together as a group will compose the group from which the planner will derive certain information that will define the transportation system characteristics.

The total size of this group may be undefined, but ideally it should be large enough to accurately speak for all people within the scope of the area's influence, while staying small enough to be manageable. It is important to obtain a cross section of the concerned population. Adjacent governmental bodies should be invited to send representatives to the group and should be kept aware of the process if they do not participate.

The wildland area should be identified by its location and function within the geographical region. The transportation network of the region should also be identified along with the development and use plans for the area and adjacent lands. Demands for the area should be identified and quantified for the uses and activities planned and allowed in this area. The carrying capacity of the area should also be computed for these allowed uses and activities. All of the above data, as well as the management objectives, should be made available to the members of the group to set the proper perspective for their role in this process.

Within the framework suggested by the data, and the general guidelines laid out by those in charge of the effort, the group component categories

should develop their transportation goals and objectives for the wildland system (See Figure 9 for an example).

The group should be presented the constraint listing from Chapter 8 to use as a guide in selecting the transportation constraints relevant to any potential transportation system for the area. The constraint listing presented in Chapter 8 should be used only as a guide; it should be reworded, added to, or deleted from to develop a constraint listing pertinent to the planning effort.

Each individual member should be given the list of constraints identified for this project and should determine the importance of each constraint for the planning area from his view point.

The method this research team has selected for developing a composite set of relevant constraints is a modification of the sum-of-years-digits depreciation model. From the set of constraints picked as relevant for the project, the individual members of the planning group should separately arrange the constraints in order of decreasing importance. This list should then be numbered consecutively from the bottom, or from the least important constraints. (See Figure 14)

The values each member assigned to a given constraint (See Figure 14) should be added together with the sum being the degree of relevance the group places on that particular constraint. All constraints should then be relisted according to the value of their sums. The constraint with the highest sum is the one the group has picked as most important, the second largest sum is next important, and so on. In the case of identical sums the constraints will have equal importance.

The ordered list of relevant constraints should be presented to the group for a brainstorming session to assign a unit of measurement to each constraint. Some of the constraints do not reflect tangible entities, but they can be quantified in some manner. (See Figure 15) The constraints of public demand versus "responsibility to the public," for example can be quantified by defining each, then stating an acceptable range for both. The overlap of these ranges can be stated in terms of how important they are. User demand may be intense for recreation and timber. Public responsibility may be to provide both from the same resource base (planning area) or it may be to utilize the area for recreation and satisfy the timber demand from another

Figure 14

Sample of Contraint Identification and Ordering

Individual Rating 1	2	3	4	Group Identified Constraints	Sum
9	7	4	8	Public demand vs. responsibility to the public	28
8	6	5	4	Limited resource	23
7	5	6	3	Allocation of limited resource (i.e., fuel)	21
3	4	9	2	Public resource needs (timber-recreation)	18
6	1	3	9	Limited amount of money	19
2	2	2	7	Activity variable with time and season	13
1	3	8	6	Topography	18
5	8	7	1	Use problems (existing)	21
4	9	1	5	Uniqueness of site	19
			45		

Constraints Ordered as to Degree of Relevance

Public demand vs. responsibility to the public	28
Limited resource	23
Allocation of limited fuel	21
Use problems	21
Uniqueness of site	19
Limited amount of money	19
Public resource needs (timber-recreation)	18
Topography	18
Activity variable with time and season	13

Figure 15

Sample of Constraint Quantification

Constraints	Quantifications
Public demand vs. Responsibility to public	Satisfy recreational demand for day use picnicking and water play maintain resource quality for future generation
Limited resource	Make the highest possible use of resource (300 acres usable)
Allocation of limited fuel	Select transportation system with high ($1.00/gallon) fuel efficiency
Use problems	Minimize vandalism, drugs increase supervision enforcement
Uniqueness of site	Protect, interpret
Limited amount of money	Select system with amount (50,000)
Public resource needs	Provide for day use recreation without altering water quality-obtain timber elsewhere
Topography	Minimial alteration desirable (7.15% average graphy)

area. This particular decision would have to be in accord with established plans for this area.

The administrative mode concerns should be introduced to the group at this point.

The administrative mode concerns is a general list of some types of concerns that the administration must be conscious of when determining the most appropriate type of transportation system for service of a wildland area.

Examples of administrative mode concerns

1. User safety
2. User costs
3. Management costs
4. Response to flexible demand
5. System/support facilities compatible with service area
6. System attractive but not an attraction
7. Protect uniqueness of area
8. System capacity equal to area capacity
9. Visitor convenience

The listing should also manipulated to accurately reflect these types of demands that must be considered in this process.

The next phase of the process should be an evaluation of potential environmental impact resultant from transportation system construction and operation. An example of this type listing is presented at the end of Chapter 8. These may be identified and ordered as to importance in a similar manner as the constraints.

The listings of the more important transportation constraints, the administrative mode concerns and the more critical potential environmental impacts should be incorporated together to produce the system requirements. This would be similar to the personnel manager's general job description which should fairly accurately describe the vacancy. The requirements need to be refined so that they indicate specific needs that can be quantified. The quantification of the requirements will be the specification that candidates must meet to be considered. (See Figure 16)

It is at this point in the process that trade-offs may have to be made between eligible specifications to find eligible candidates within an acceptable price range.

Figure 16

Sample System Specification

Quantification	System Requirement	System Specification
Satisfy recreational demands for day use maintain resource quality	System should lend itself to day use - without degradation of site	Storage capacity for day use equipment unobtrusive - limited pollutants - secondary impacts
Make highest possible use of of resource (300 acrea)	Minimal space requirements for system	System with minimal on site space requirements
Allocation of fuel $1.00/gallon	High fuel efficiency	Minimal fuel costs/seat mile
Minimize vandalism, drug use Increase supervision and enforcement	Ease law enforcement process - Users highly visable to others desirable	Open highly visable passenger areas
Protect and interpret site	Should lend itself to interpretation	Interpretation devices
Select system with price range of $50,000	Price ≤ $50,000	Less than $50,000 initial cost
Day use - no alteration of water quality	No pollutant to water	No production of water pollutants
Minimum topography alteration	Use existing road no cut and fill	Able to use existing roadway

Because of the nature of the process that led to the development of the specifications they can be manipulated with some idea of the importance of each.

Summary

This framework has been developed conceptually to indicate the type of mode design/specification methodology that may prove feasible for use in wildland areas. It will be refined and tested in phase two of this research to the point that, hopefully, the area managers can use it to justify the selection of the most appropriate mode for their particular application.

CHAPTER XI
Summary and Conclusions

Through the course of research activities conducted in the preparation of this study, it became readily apparent that the search for workable solutions to forest transportation problems is by no means a simple transfer of urban technology to the wildland environment. Rather, as the report has illustrated, the planning and design considerations are numerous and complex, the economics of some attractive alternatives are prohibitive, and the web of institutional obstacles to implementation is formidable.

A large amount of time and effort has been expended in the development and testing of many mass conveyance prototypes. As the nation and its leaders become more aware of the realities of the finite limits of our fossil fuel resources, the urgency of searching for solutions to problems associated with energy and locomotion will, we believe, take on the dimensions of our post-Sputnik thrust to achieve international supremacy in aerospace technology and exploration. Interestingly enough, much of the spin-off of the ambitious and successful national commitment to space exploration has found its way into the engineering advances incorporated in our most innovative transportation mode prototypes.

Environmental concerns in the planning and development of transportation systems have increased drastically since the beginning of the decade. As a result of the procedural requirements for project evaluation required by the National Environmental Policy Act of 1969, a myriad of both short term and long term environmental implications of any development activity on local, regional, and even national ecosystems must now be identified and thoroughly analyzed. Because of environmental considerations and interactions of different types of development and a more intensive focus on truly comprehensive planning, there has been a shift towards more environmentally oriented planning and analysis. In a growing number of situations, there is an increasing awareness and acceptance that the transportation system is at least one of the elements, if not the key element influencing many land use activities. Roads are no longer planned for single purpose activities. The entire network of links, in most instances, is considered in terms of a host of factors, many of which extend in influence far beyond the forest administrative unit.

In searching for solutions to problems of transporting people and products through wildland areas with minimal environmental impact, planners and administrators find themselves reassessing the basic process of problem identification. As we met with various Forest Service planning teams, it became apparent that transportation analysis needs to embrace a host of factors relating to issues such as energy conservation, operational efficiency, and minimal environmental degradation. Simply moving people and products from point A to point B along the shortest and fastest route no longer is the prevailing attitude, sympathy, or requirement. We also found comment about a more aware and vocal public seeking greater participation in the planning process.

A great deal of emphasis should not be placed on the utilization of the highly sophisticated and expensive transportation modes for solutions to people movement in wildland areas. Attention should be placed primarily on vehicles that can operate over the existing link system. Engineering technology should be focused on the development of vehicles with minimal energy requirements, that emit minimal pollutants, and that are capable of moving people, equipment, and products through wildland areas quietly and efficiently. These vehicles should be multipurpose in nature, easily convertible and capable of operating on a year-round basis.

Forest land use planning should become more comprehensive in scope with increased linkage with local and regional planning activities outside the forest administative boundary. The framework for developing transportation planning and solution strategies within the forest unit often requires input and action from other governmental bodies and private parties.

The level of knowledge about specific vehicle characteristics and operational economics of mass conveyance systems now in operation is incomplete and frequently misleading. Our field discussions on these points were limited by the lack of this information, either from the manufacturer or the entrepreneur. Some omissions may have been intentional for legitimate reasons. However, the absence of such data limited the thoroughness of our assessment of these alternatives. Also, there is a void in the understanding of the vehicular needs of the full range of potential visitors to forest recreational areas. This data is essential to the engineer and designer in the research, development, and testing of alternative vehicles and systems.

The process of comprehensive forest land resource planning should result in the identification of all potentially suitable alternative recreational areas within a forest management unit so that it would be feasible to consider more alternative transportation systems and/or modes. In many situations it may well be feasible to encourage development by private entrepreneurship under special use permits. In such situations or where plans involve enlargement of existing operations, the permit application and review process should include a thorough assessment of the transportation needs of the development and how the purposed development can be integrated with the forest and regional transportation network. While the Forest Service itself cannot provide the transportation hardware, it can exert strong influence on the permittee in his selection of such. Forest Service planners can develop the specifications for range of transportation modes which can be provided by concessionaries. This is similar to the procedure used by the National Park Service. Also, Forest Service management policies with respect to the use of popular recreational areas and recreational travel on forest system roads can influence the nature of recreational travel as well as encourage users to join with the Forest Service in the search for more desirable alternatives. This situation is documented and clearly evident in the Sabino Canyon case study.

Clearly then, one can conclude that the national forest as a resource area, the multiple functions it performs or goods and services it renders and the institutional framework under which it is administered present difficult challenges for the transportation planner. Each forest user group presents a different set of transportation needs, each of which involved different kinds of environmental impacts. The key in planning is to seek a balance between highly specialized systems and the more general systems which can accommodate a wide range of vehicles. To some extent, the Forest Service has accomplished this balance in its research on the various combinations of equipment which can be used to remove timber from sites where extensive haul road construction is not appropriate.

Our inquiry has demonstrated that the research and development efforts of private industry, in response to the need to solve urban transportation problems, have yielded a substantial and certainly impressive array of vehicles and energy efficient, environmentally sound propulsion systems.

Many of these are very specialized and astronomical in cost. A few could be adopted for use in specific wildland situations. It is possible to assess the environmental performance characteristics associated with the development and operation of each system. The next step is to develop a procedure whereby the specific planning specifications and performance criteria established for a particular situation can be translated into the most appropriate system.

APPENDIX A

Case Studies

APPENDIX A

Case Study 1

Mesa Verde National Park, Colorado

Mesa Verde National Park was selected for a case study because of the internal public transportation system that has served a portion of the park since 1973. The system has been mentioned in various literature as one of the National Park Service solutions to automobile associated problems encountered in some national parks.

Mesa Verde National Park (Mesa Verde) is a 52,000 acre park located adjacent to the Four Corners area in Southwest Colorado. The park contains numerous archeological ruins from an ancient Indian culture which inhabited the area from the 6th century A.D. (Figure 17)(83)

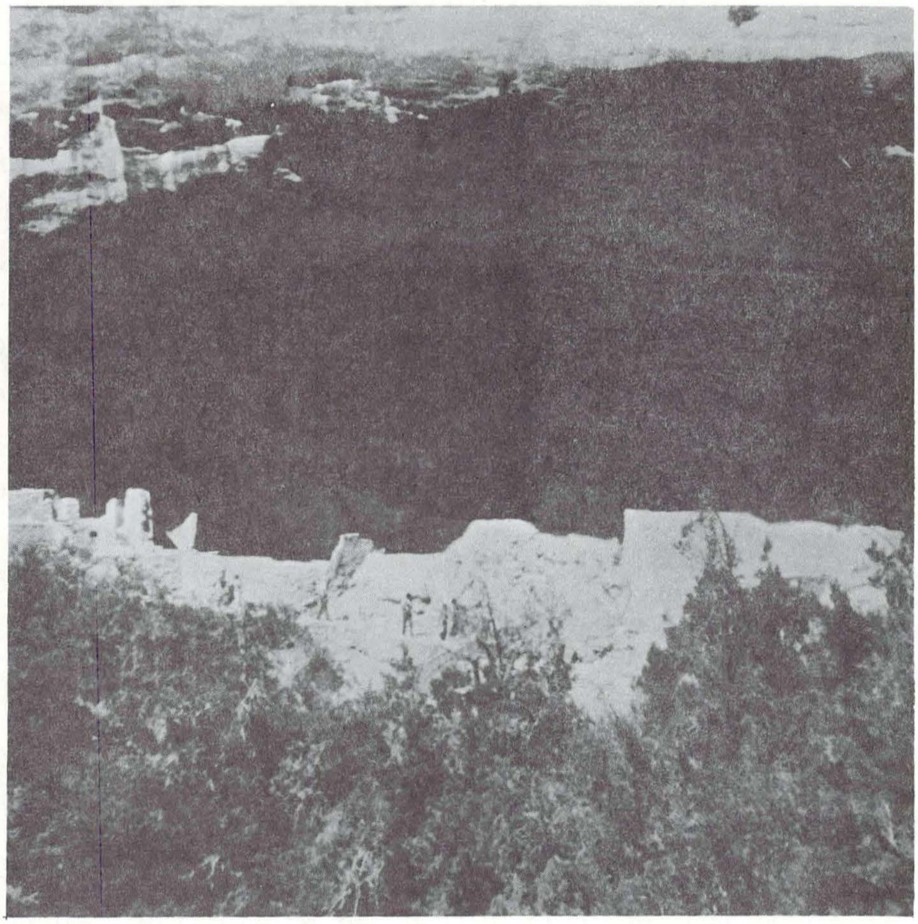
Mesa Verde contains two Mesas, Chapin and Wetherill. (see Figure 18) Chapin Mesa has been open to the public since 1900 when the park was established and Wetherill Mesa has just recently been opened to the public. Chapin Mesa is the portion of the park that the majority of visitors are most familiar with because of the many years it has been open, and because it contains most of the park facilities.

Wetherill Mesa has been under an extensive archeological survey for several years, during which time it was closed to the public. The only access to Wetherill Mesa was by a narrow two lane gravel road built 12 years ago. The access road was not intended for visitor use. It was surfaced for visitor use in 1971 after the Park Superintendant was mandated to open the Mesa area as soon as possible. (84) Both the Park Superintendant and the Chief Park Archeologist have conceeded that the existing road alignment was not ideal for any use with its 22° curves and grades in excess of 13%. (84) Both commented that the grades, at places on the road, are too steep for safe vehicle use. (84)

Wetherill Mesa was to be opened to the public to reduce visitor impact on Chapin Mesa which was having to absorb almost 500,000 visitor days per year. Wetherill Mesa contains various ruins that could be made accessable to visitors initial plans; however, provided for the opening of only three sites. All visits to Wetherill Mesa are Ranger-guided tours of up to 50 people. The Park Service feels that the carrying capacity for

Figure 17

Indian Ruin in Mesa Verde National Park Colorado



the park is determined by the capacity of the ruins to absorb visitor impact. According to the Park Service one Ranger-Interpreter can control a tour of 50 people at one time. The carrying capacity of Wetherill Mesa is computed on the basis of 50 people per tour per ruin. In 1973 and 1974 only the Long House ruin on Wetherill Mesa was open to the ranger guided tours.

Between 1969 when transportation planning began for the proposed opening of Wetherill Mesa, and 1973 when the bus system began operating, the existing road was surfaced and a 500 car parking lot was constructed on the Mesa. Mesa Verde Company, the Park Concessionaire, was given two weeks notice in 1973 that private cars would be excluded from Wetherill Mesa, and that they had the first right of refusal in establishing a public transportation system to serve Wetherill Mesa. (85) The system would have to operate on the existing road-way and would have to be able to move 10 fifty-passenger tours per day round trip over the twelve mile distance between the visitor center on Chapin Mesa to the parking lot on Wetherill Mesa. A shuttle from the parking lot to the ruins was also included in this proposal. (85) Figure 19 shows the difference between the circulation systems in use on the two mesas.

The system in operation during the 1973 and 1974 seasons (June to September) consisted of two buses and one Mini-bus trackless train. (Figure 20) The buses transport passengers the 12 miles from the visitor center to the Wetherill Mesa parking lot while mini-buses move visitors from the parking lot to the ruins site. The Mesa Verde Company purchased the Mini-bus from a shopping center firm in Denver, and leases the school buses from Associated Charter Bus, Inc. of Van Nuys, California. The buses are used by a school system during the year, and are available to the concessionaire during summer vacation. In 1974 the Mesa Verde Company paid $40. per day for each bus. The company must supply their own drivers, fuel, and light maintenance. The company owns another bus for back up and an airport "mule" for mini-bus back up. No information was available concerning operational costs or fuel mileage of any of the vehicles. (85)

The visitors must pick up a free ticket at the visitor center for the Wetherill Mesa tour. The Park Service pays the concessionaire $1.25 per seat (50 seats) per tour per day. Originally ten tours per day

Figure 18

Map of Mesa Verde National Park

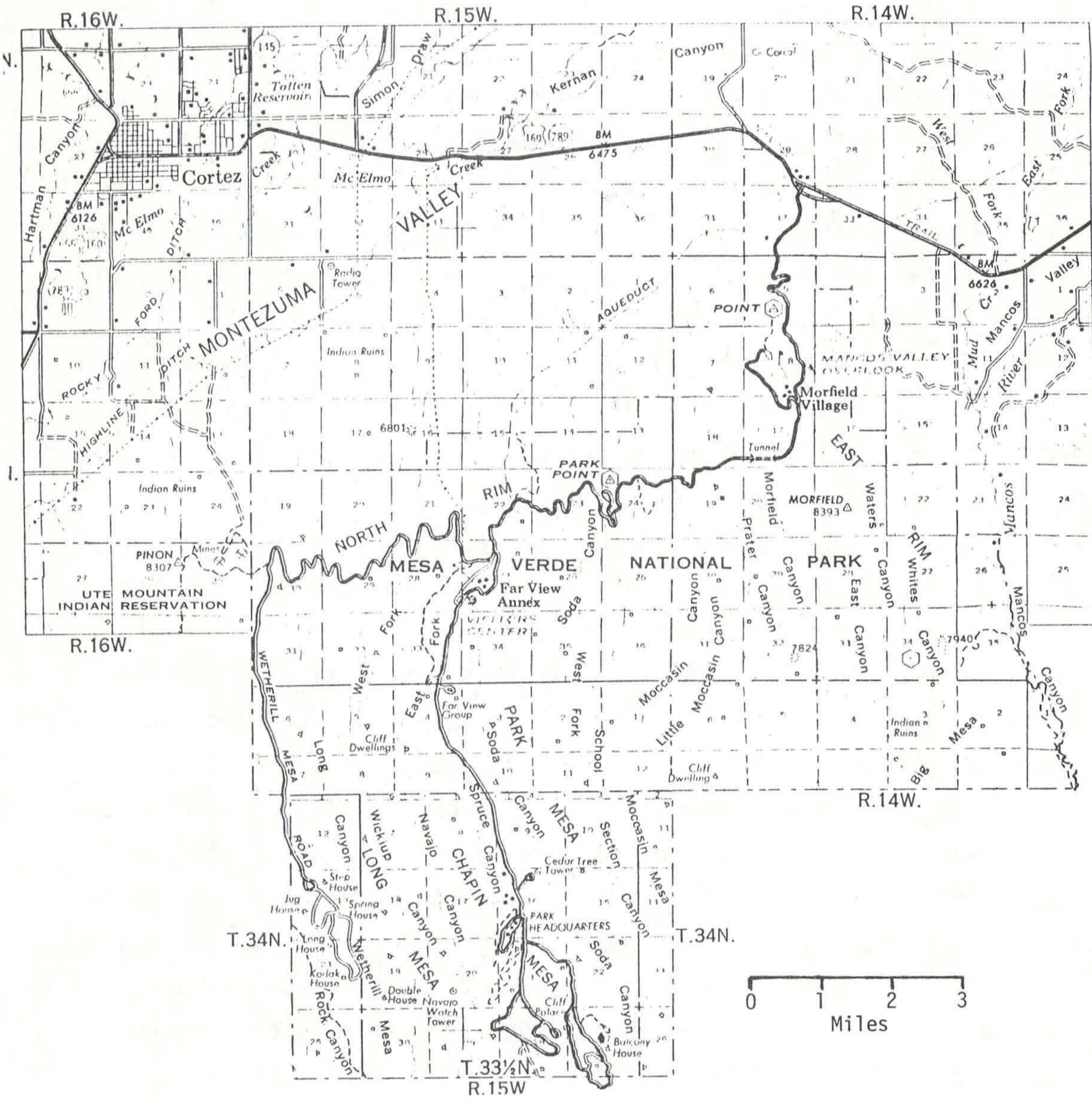
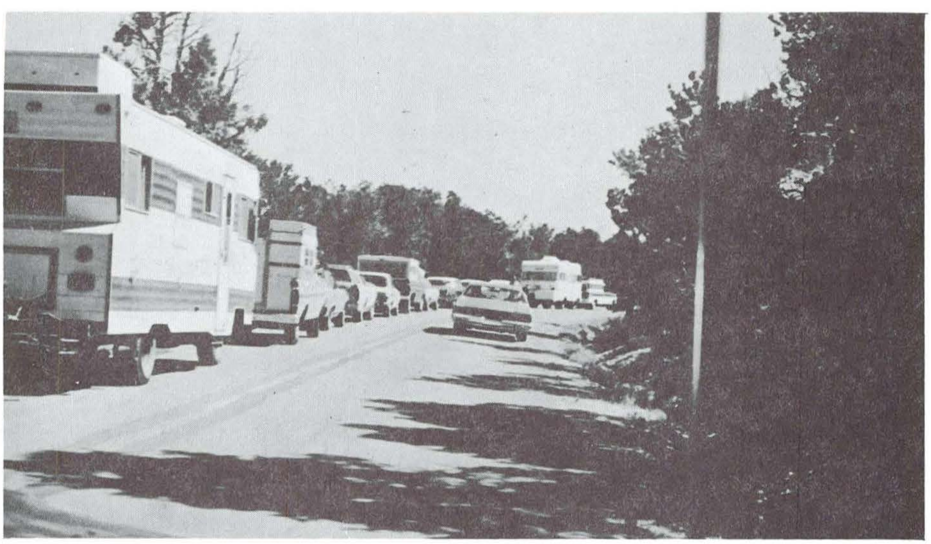


Figure 19
Comparison of Wetherill Mesa and Chapin Mesa

Wetherill Mesa Road Used Only in Buses



Private Vehicles on Chapin Mesa Road
Mesa Verde National Park, Colorado

Figure 20
Bus and Mini-bus Used at Mesa Verde National Park, Colorado (1974)

were planned but this has been reduced to eight per day. The interior bus shuttle during the 1973 season (94 days) carried 38,280 people or 14.3% of the total park visitors to Wetherill Mesa. The ten round trip tours averaged 85% of bus capacity for the entire summer. (84)

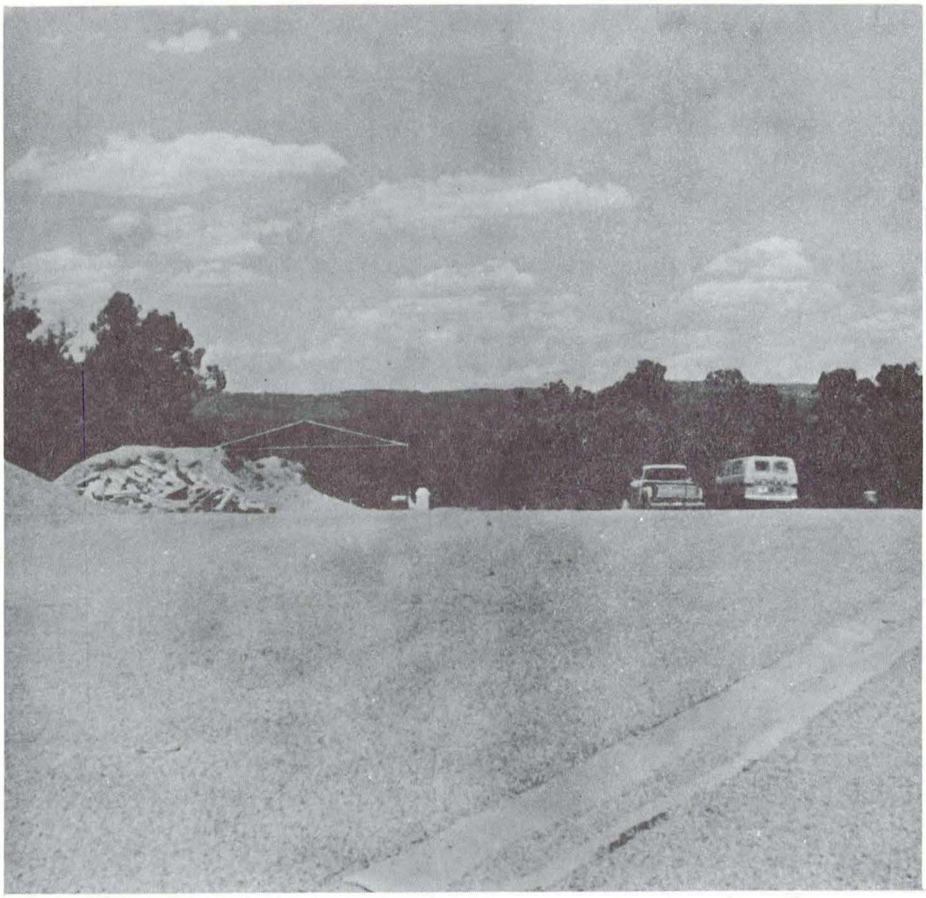
The existing system is a heavily controlled experience for the passenger without being obviously regimented. The passenger must have a ticket, has to ride and tour the one site with the entire group. No user complaints have been brought to the attention of the Park Service and no exceptional praise has been received. The attitudes seem to be that the system is there, there are no alternatives and the trip is part of the park experience.

The road was not constructed for regular use by the heavy buses and is deteriorating badly. (84) During our visit we observed that this paved road surface was breaking up on the grades where the buses frequently braked and accelerated.

Summary

The bus - mini-bus system in use in Mesa Verde National Park is well used, and it does serve the required function of moving people from one mesa to the other. However, the unused (except for mode transfer) 500 car parking lot on Wetherill Mesa is one of several indications that a lack of comprehensive planning is behind the existing system. (Figure 21) The one outstanding feature of the system is that no substantial investment in capital has been made which would have to be amortized before the existing system could be changed. If a better proposal is presented and finances become available in the future, the bus - mini-bus system can easily be phased out. If this is to be the case with the Wetherill Mesa system, hard data about use will be available to the planners at nominal cost.

Figure 21
500 Car Parking Lot on Wetherill Mesa



APPENDIX A

Case Study 2

Denver and Rio Grande Western Railroad
Durango - Silverton Route

The Denver and Rio Grande Narrow Gauge Railroad located in Southwestern Colorado is an extremely unique recreational transportation system. The line connecting the rich mining operation located around Silverton and Durango was built in the 1800's. The 44 mile track (Figure 22) was constructed in the incredible time of nine months using only available technology of the period. The line paid for itself by transporting supplies into Silverton and by removing some 300 million dollars of ore from the Silverton mine fields.

The railroad is operated from the last part of May to the end of September. The privately owned right-of-way is bordered by the San Juan National Forest and runs parallel to the Animas River. The trip begins at the Durango Station (elevation 6520') and ends at Silverton (elevation 9288') four hours later. The first train departs Durango at 8:30 a.m. and the second at 9:30. The trains stop, side by side, on the main street in Silverton where there is a layover to allow passengers the opportunity to shop, eat and observe the old mining town.

The Denver and Rio Grande Western Agent, Amos Cordova commented on the system during the summer of 1974. According to Mr. Cordova:

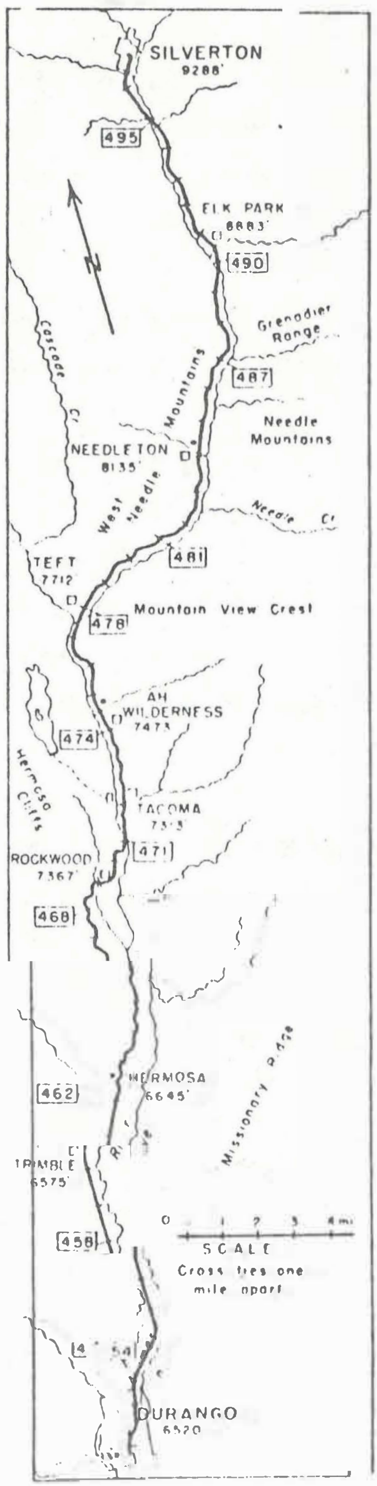
> The drawing point for the system is that people want to ride a real 1800's train and the line wants people to have the opportunity. The scenery of the San Juan National Forest and the Animas River Valley are big drawing points but people ride the train for the primary experience of "reliving history." (86)

Mr. Cordova stated that it would be impossible to figure replacement costs for the system because the equipment is all antique with the exception of some cars that were custom built in 1970 for $20,000 each. Mr. Cordova, because of a company policy would not release information on the profits or losses of the line. He did, however, observe that it would not be economically feasible to profitably construct and operate a similar facility today. (86)

The system has several unique characteristics that are one of a kind. It is the only Class I narrow gauge, steam powered train that

Figure 22

Map of Durango - Silverton Route



Map adapted from the book "Cinders and Smoke" by Doris B. Osterwald

Figure 23

Passengers Enjoying Scenery

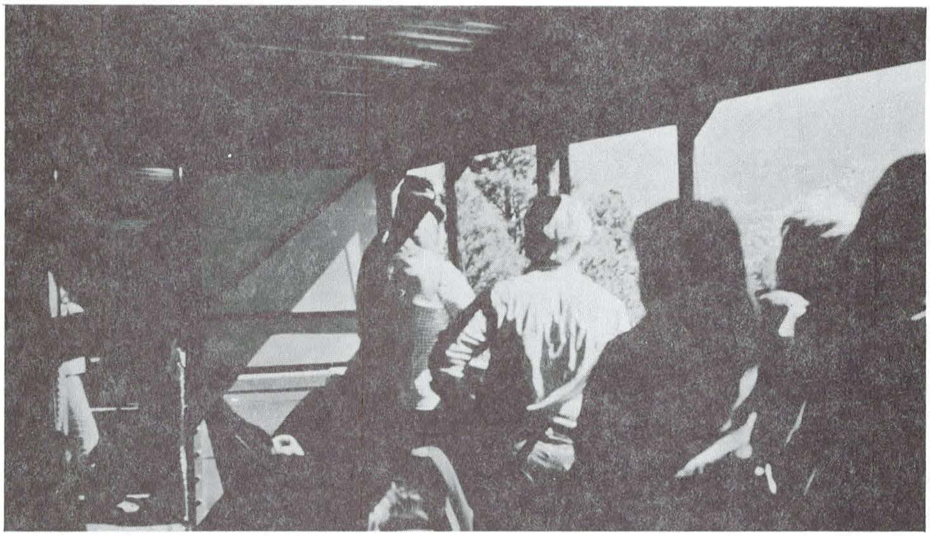


Figure 24

Hikers Using Train for Access to Animas River Canyon

Figure 25

1800's Narrow Gauge Steam Train

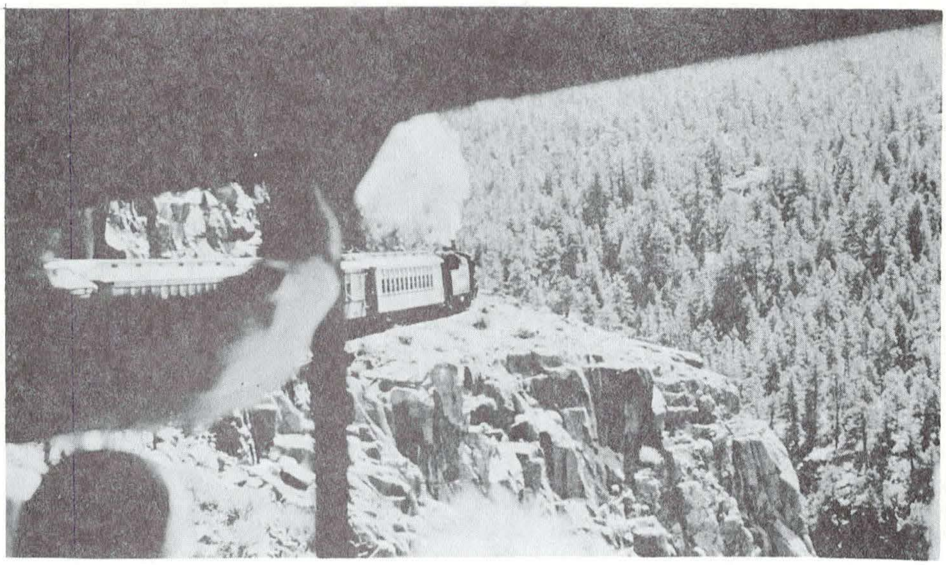


Figure 26

Private Guest Ranch Accessable only by Train, Foot, or Horseback

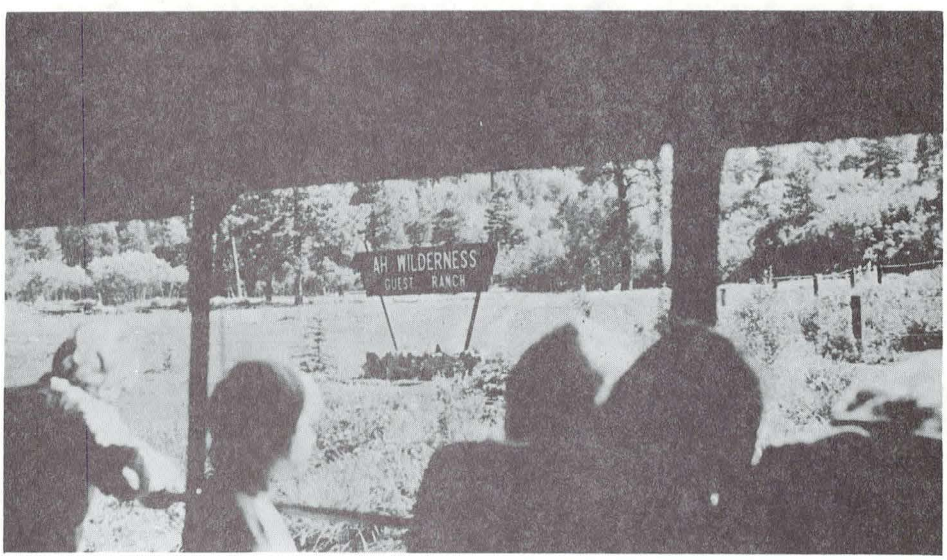


Figure 27

Portion of Durango - Silverton Travel Table

TRAVEL TABLE

Welcome aboard the last operating narrow gauge passenger train in the United States, except Alaska. You'll be taking a historic trip from Durango to Silverton, and as you travel up the Animas River through San Juan National Forest, we invite you to observe key points along the way.

By using this folder and map as a railroad travel-table you will be able to place your whereabouts anywhere along the route. The mileage figure to the extreme left below identifies railroad mile posts along the track, indicating the distance by railroad from Denver.

To assist you in recognizing points of interest, the Forest Service has erected signs marking streams, mountain peaks, railroad sidings and points of historical interest. The name of each sign appears in capital letters in the table below. Where possible, sign locations are correlated to railroad mile posts.

Mile Posts	Miles to Durango	Points of Interest	Miles to Silverton
452	0	In the 44 miles from Durango to Silverton elevation increases from 6,520 to 9,288 feet. Although the exterior National Forest boundary is crossed about 5 miles north of Durango, the train travels through private land in the Animas Valley for another 12 miles. The tree covered mountains on either side are part of San Juan National Forest.	44
		HERMOSA DRAINAGE — noted for its large elk herd; it is a favorite hunting spot.	
462	10	HERMOSA CREEK — the railroad water tank on the west side of the tracks has been in use since 1882.	34
		Cross US Highway 550.	
464	12	MISSIONARY RIDGE — named in the early days by a company of soldiers stationed at nearby Fort Lewis. As Civil War veterans, they had fought a battle on Missionary Ridge in Tennessee. The road switchbacking up the ridge is used by timbermen, hunters, fishermen and sightseers as access to San Juan National Forest.	32
468	16	Shalona Lake — crossing US Highway 550.	28
469	17	ROCKWOOD — an old lumber camp and stagecoach station.	27
		SAN JUAN NATIONAL FOREST (2,086,462 acres) established by presidential proclamation in June, 1905. See story reverse side.	
	19	ANIMAS RIVER CANYON — this section of track is known as the "high line" and is 300 feet above the river. The rail bed was blasted from solid rock.	25
471	19	ANIMAS RIVER — Elev. 7,200 — the train crosses the river for the first time and is now on the east bank. The river was named by Spanish explorers, Escalante and Dominguez, who called it "Rio De Las Animas Perdidas," or "River of Lost Souls."	25
472	20	CRAZY WOMAN CREEK — a tributary of Canyon Creek not visible from the trail, but located about one mile east of the Animas and up Canyon Creek which you will cross in a moment.	24
		TACOMA — Elev. 7,313 — the penstock (large silver pipe across the river) drops water 1,000 feet from Forbay Reservoir to operate the turbines in this hydroelectric power plant.	

operates on a regular schedule in this country. Although some four to five hundred people ride each train, only 1500 hikers per month use the train for access into the Animas River area. (86) The train will make stops along the route where hikers or fishermen can get off or on. Among these stops is the privately owned guest ranch, AH Wilderness, which is accessible only by rail, foot or horseback. (Figures 23, 24, 25, 26)

Mr. Cordova indicated that the railroad works very closely with the Forest Service. There is some problem with fires started from cinders as the coal burning engines pass through the forest in hot summers. The railroad employes its own fire control staff, and owns fire fighting equipment and is also under a contract with the Forest Service to transport fire crews and equipment into the area to fight other man or nature caused fires.

The only environmental problem created by the railroad that has been brought to the attention of the Denver and Rio Grande Western is the disposal of restroom wastes, which are now chemically treated.

The system operation for each day begins with a small gasoline powered vehicle starting up the tracks before the first train to inspect the track and clear any debris. The engines, loaded with coal and water, build steam and move back and forth at the Durango Station checking systems before hooking onto the passenger cars. Some of the cars are open sided with bench seats facing the sides. The cars are manned by conductors who sell tourist items and remind passengers not to lean out of the cars due to narrow clearnace in some of the rock cuts. The only interpretation provided was via the Forest Service Travel Table (Figure 27) available at the station which includes a map and folder describing and identifying the various scenery by mile posts and signs along the tracks. There are also several commerical guides for sale at the station which describe the route.

The second train is followed by a vehicle similar to the one that checked the tracks to spot possible fires or track problems that must be corrected before the return trip. The railroad stops operation after September because of snow. Spring activities, before opening of the line includes track repair and clearing of land slides caused by snow avalanches. Mr. Cordova indicated that large quantities of road bed and track must be replaced each spring.

Tickets for Round Trip - 1974
Adult $9.00
Children $5.00

A bus service operates to return passengers to Durango if they do not wish to ride the return trip. The bus trip saves three hours of passenger travel time.

Summary

The Durango to Silverton route of the Denver and Rio Grande Western Railroad appears to be economically feasible as a form of recreation transportation only because of the unique preexisting conditions. Very few transportation facilities from the 1800's are intact enough to be operated profitably, without large expenditures. Mr. Clovis Butterworth, agent (88) for the Cumbres and Toltec Scenic Railroad (located several miles south of Durango and owned by the states of Colorado and New Mexico) noted that liability insurance for such an operation commonly costs 25 percent of gross revenue if it can be obtained at all. (As a Class 1 Railroad, Denver and Rio Grande Western can insure themselves.) (88)

Appendix A
Case Study 3
Sabino Canyon Recreation Area, Arizona

The Sabino Canyon recreation area is located at the base of the Santa Catalina mountains near Tucson, Arizona. The area is situated just inside the boundary of the Coronado National Forest. Sabino Canyon is a heavily used regional recreation area, drawing nearly one half million visits annually for the past several years. (89) The major drawing power of the desert canyon stems from its ruggedness and the climatic relief available because of the small stream and large trees contained within the canyon. (89)

Sabino Canyon was picked as a case study on the recommendation of the Land Use Planning Staff of the Region Three Forest Service Office because of the unique circulation system now being used in the canyon area. The circulation system is also currently under review by the Coronado National Forest Staff in Tucson, Arizona.

History

The existing circulation system in the Sabino Canyon recreation area has evolved from a wagon road constructed some 45 years ago, to a well maintained asphalt surfaced roadway. Figure 28 illustrates some of the more important dates that relate to the canyon's development as a recreation area.

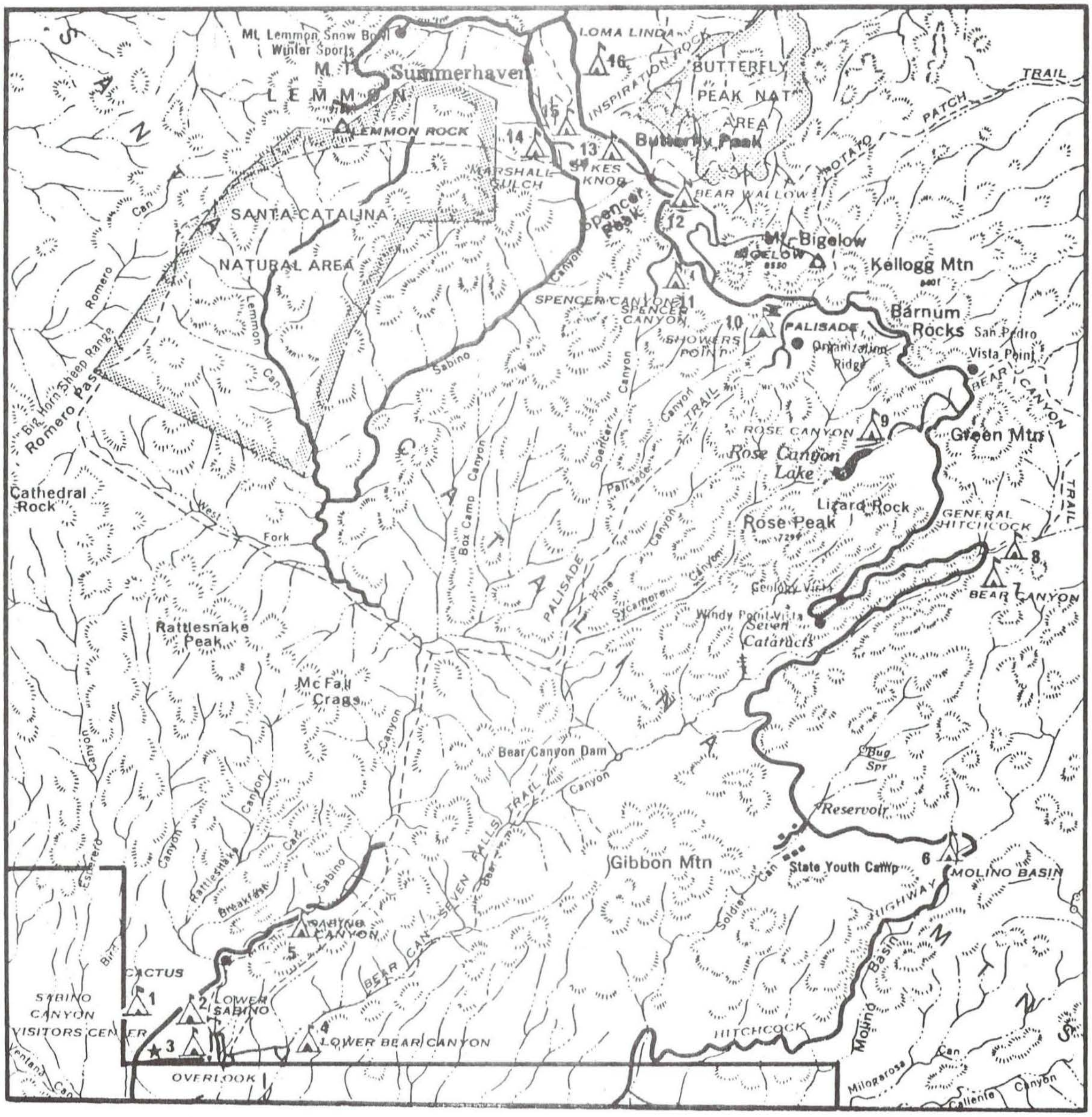
Before the roads in Sabino Canyon were closed in 1973 to facilitate the construction of a sewer line, capacity of the area was determined by the number of private vehicles which could enter the area without completely blocking the roads. (90) Figure 29 shows a map of the immediate area around Sabino Canyon while Figure 30 is a representation of the Sabino Canyon area itself. As shown in Figure 30 the area circulation system consists of two separate links which share a node in the vicinity of the visitor center. The shorter link (Bear Canyon road) runs almost parallel to the southern forest boundary and is approximately 1.5 miles long. The longer link is the Sabino Canyon road (3.9 mile long) which runs parallel to the main area drainage.

Figure 28

History of Sabino Canyon

Before 1930	Wagon road led into canyon
1930's	WPA improved road--built nine stone bridges (Tucson population 30,000)
1965	LWCF Fee System
1967	Instituted Reduced Fees
1969	482,176 visitors
July 1972	LWCF Fee System removed Use increased by 50%
October 1973	Canyon closed for construction for sewer line--only Bear and Lower Sabino reopened
1973	629,232 visitors (estimated)
August 1974	Public input 9 to 1 in favor of some kind of vehicle restriction
	Tucson area population 7,400,000
Spring 1975	Research team visit

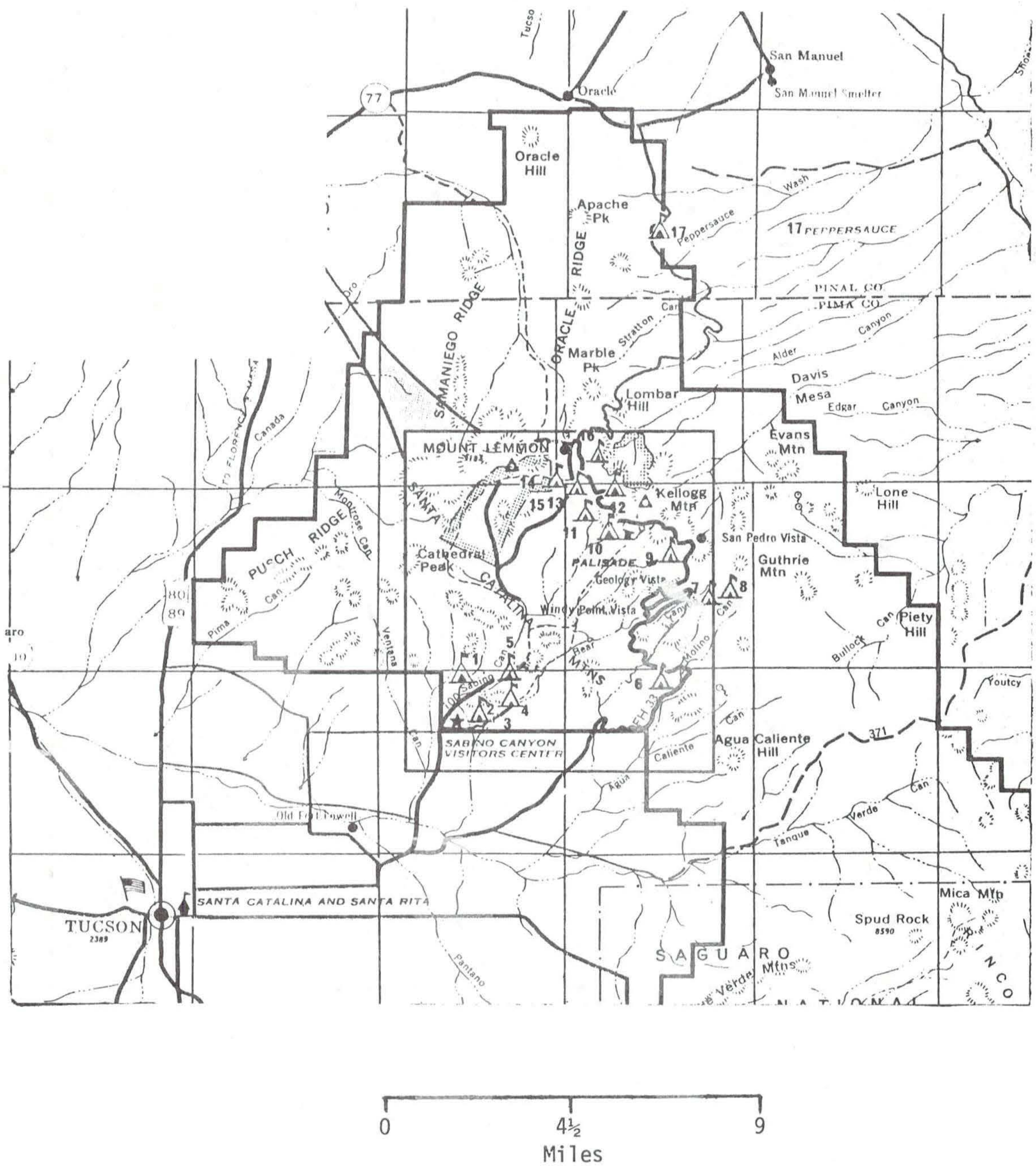
Figure 29
Map of Sabino Canyon Area



0 1 2 3
Miles

Figure 30

Map of Sabino Canyon and Mt. Lemmon



Existing System

Public response to the closing of the canyon road during construction was unexpected. People in the Tucson area began contacting the Forest Service to tell them that they enjoyed the lack of vehicles in the area. (90) The Forest Service decided to reopen only the roads in Bear Canyon and the lower 1.5 miles of Sabino Canyon. The 2.3 miles of Upper Sabino Canyon were restricted to non-motorized traffic. (See Figure 31)

This action on part of the Forest Service has drawn praise from some and criticism from others. (89) The majority of users appear to be in favor of the non-motorized approach for access to the upper canyon. Several types of individuals are opposed to the limited access plan because they feel they have been restricted from the best portion of the canyon because of their personal limitations. Those with physical disabilities, the elderly, and parents with very young children feel that they have been deprived of the right to view the upper canyon scenery. (89)

In an effort to be responsive to all potential users of the Sabino Canyon area, the Coronado National Forest staff has identified their preliminary objectives, alternative management systems and criteria for comparison of alternative. These are presented in Figure 32. Alternative management system number four describes the management system that has been employed since the area was reopened. The justification for not considering the alternative of continued automobile access to all parts of the canyon was based on public input which ran nine to one in favor of some type of vehicle restrictions for the canyon. (89)

Transportation Requirements

Because the determination of the maximum number of people that will be allowed into the Sabino Canyon area at one time was deemed to be of primary importance, the Forest Service has computed carrying capacity for the canyon using several methods. (89) Exclusive day use was determined to be desirable from an environmental impact standpoint because of vegetation destruction for campfire use associated with camping. (89) The carrying capacity figures for day use relate to social or cultural factors because, with the exception of vegetation, impacts for most recreational uses on the rugged canyon would be minimal (See Figure 33 for examples of use). Past

Figure 31

Motorized Vehicle Barrier at Entrance to Upper Sabino Canyon

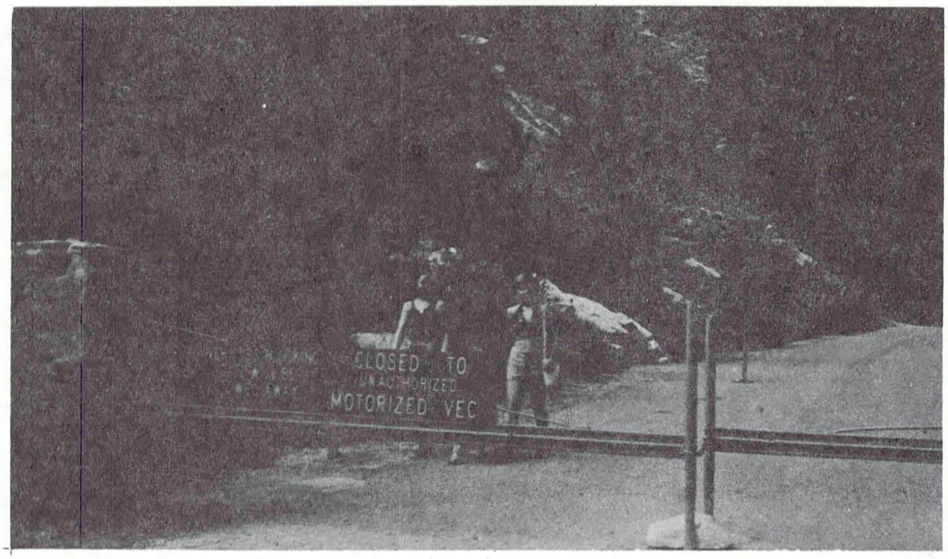


Figure 32

Management Objectives, Alternative Systems and Criteria for Comparison

Sabino Canyon Study

Following the closing of the Sabino Canyon recreation area in 10/73, a large volume of public input was received by the Forest Service. A multidisciplinary team was formed to examine this input and has so far identified the following objectives, management systems and criteria. As these are only preliminary, they are open to your examination and revision.

Objectives:

1. Enhance experience of forest visitors.
2. Emphasize the natural and environmental factors of this experience.
3. Provide interpretive and educational services and opportunities.
4. Maintain and/or improve the quality of the ecosystem (soil, water, air, vegetation, wildlife, people).

Alternative Management Systems:

1. Allow no personal motorized vehicles or public transportation in any areas; hiking and bicycling only.
2. Close entire area to all personal motorized vehicles and provide public transportation for all areas (design public transport to accommodate wheelchairs).
3. Close Upper Sabino to personal motorized vehicles; allow only public transportation in Lower Sabino and Bear Canyons.
4. Close Upper Sabino to personal motorized vehicles leaving Lower Sabino and Bear Canyons open to them. No public transportation provided for any area.
5. During the higher demand portion of the week (usually weekends and holidays) allow only public transportation for all areas. Leave all areas or designated areas open to personal motorized vehicles during periods of less demand (usually week days). Public transportation should be able to accommodate wheelchairs.
6. From the first of February through the last of May allow only public transportation. Open to personal motorized vehicles the rest of the time. Public transportation should be able to accommodate wheelchairs.
7. Keep entire area closed and provide specialized tour vehicles for the physically limited. (no cars)

NOTE: To continue with personal motorized vehicles was not included as an alternative. (past input)

Criteria for Comparing Alternatives:

1. Improve the public safety.
2. Provide for the physically limited (very young-elderly handicapped).
3. Minimize visual pollution.
4. Minimize noise.
5. Maximize opportunity for wildlife observation.
6. Minimize problem such as vandalism, litter, drugs, theft, etc. (89)

Figure 33
Common Uses of Sabino Canyon Area Coronado National Forest

mistaken data, a site inventory analysis, and a linear spacing approach were used to arrive at a carrying capacity figure for the area. It was determined that the carrying capacity for the area is somewhere around 2,200 people at a given time. (89) The past use data was biased because of several factors. Figure 28 indicates some of these factors that have influenced past levels of use. However, the linear spacing approach, at three persons per 100 feet plus the capacity of recognized gathering areas, and the site inventory evaluation indicate that past use figures of 2,190 average visitors at one time was close to the figures computed for carrying capacity. The site inventory approach capacity indicates that 2,200 visitors at one time is reasonable, while the linear spacing approach indicates 2,300 visitors at one time is justifiable. (89)

The alternative management systems presented in Figure 32 were identified and evaluated by the criteria for comparing alternatives listed in the same figure. All alternatives were evaluated and the preliminary decision was made to keep Upper Sabino Canyon closed to motorized vehicles and allow continued use of private vehicles in Lower Sabino Canyon and Bear Canyon. (89)

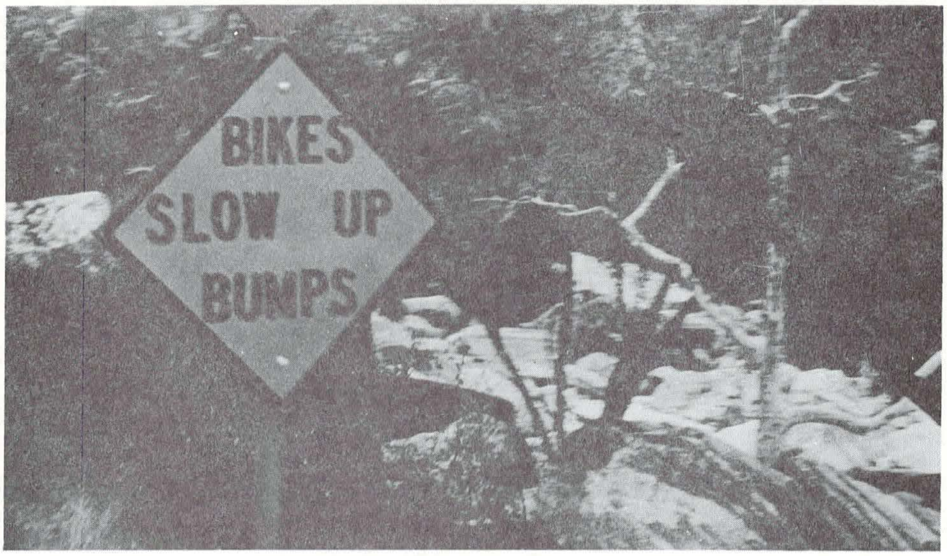
Present System

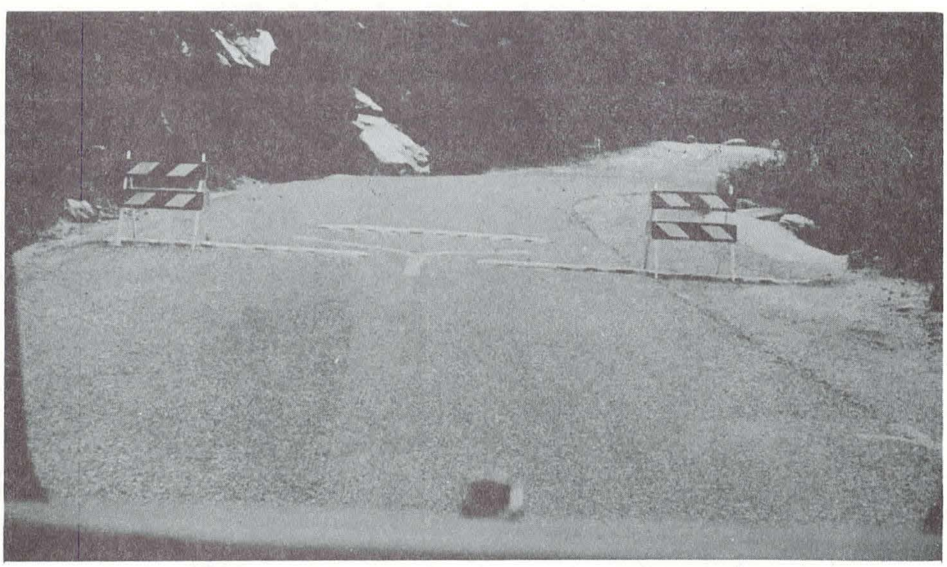
The present management system permits users across to Upper Sabino Canyon by means of foot, bicycle or horseback. The only problems encountered so far have related to bicycle accidents. Fairly steep grades and sharp corners on the road have made the construction of "bicycle bumps" necessary to slow riders down as shown in Figure 34. Private vehicles are allowed on the roads in Lower Sabino Canyon and Bear Canyon. With the exception of the previously mentioned persons who are physically limited and want to see Upper Sabino Canyon, most user comments have been favorable about maintaining the management system. (90)

Future Transportation Planning

The Forest Service has not decided whether the present system will become permanent or if one of the other alternatives should be further studied. The existing system fulfills the stated objectives and selection criteria at minimal cost. It is possible that one of the other alternatives, or one not yet conceived of, may meet the requirement better in the future.

Figure 34
Bike Bumps on Canyon Roads





Because of the proximity of the area to the forest boundary and the metropolitan Tucson area future planning will involve representatives of the City of Tucson, Pima County and the Forest Service. (90) Because the Sabino Canyon recreational area provides a unique resource for the region there is a need for a joint comprehensive planning effort involving city, county and forest personnel for matters relating to a change in use of the area and/or adjacent areas. (90)

It would appear possible that a jointly planned and financed public transportation system operating between collector points in the City of Tucson and the Sabino Canyon area may be a viable alternative to be considered in the future.

Mt. Lemmon

Mt. Lemmon (Figure 35) contains the headwaters of Sabino and Bear Canyons. Because trails heading out of the Sabino Canyon recreation area lead to various points on Mt. Lemmon, the Coronado National Forest staff suggested that this study team tour the area. The conifer forest located on top of Mt. Lemmon is located 30 miles from downtown Tucson and is accessable by a two lane paved road. (90)

Currently, there are no plans to change the transportation system linking Tucson to Mt. Lemmon; however, because of the nature of the Mt. Lemmon area and because of its proximity to a major metropolitan area the circulation system would lend itself to further study.

A small ski area, summer homes, a small community, and various recreational areas (Figure 36) are located on the mountain as well as several electronic installations.

The Mt. Lemmon area appears to be a fairly typical example of a wildland transportation system. There are various uses of the area that demand certain levels of transportation. The volume of traffic on the existing road does not appear to be high enough to justify any of the conventional forms of mass conveyance. The link is in place, and because of environmental and economic considerations associated with link construction, it would probably have to serve for any alternative mode. The Mt. Lemmon area is a regional recreational asset and public transportation may be a feasible alternative to the residents of the area given certain conditions. If the price of fuel

Figure 35
Campground on Mt. Lemmon

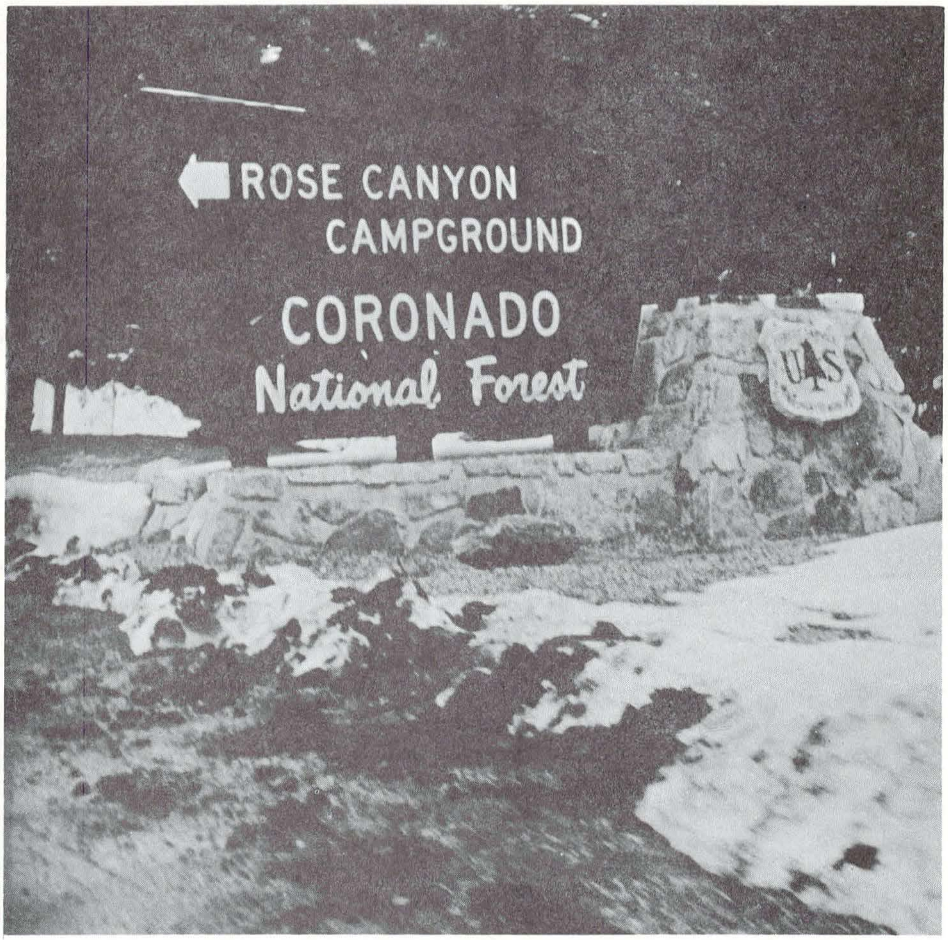
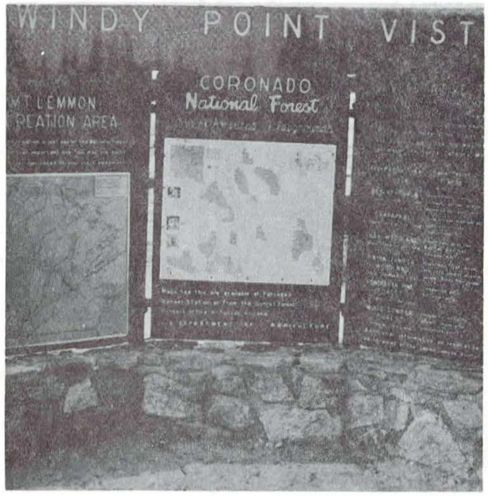


Figure 36
Uses of Mt. Lemmon

Figure 36 Continued
Uses of Mt. Lemmon



for motor vehicles increases significantly in the future it may be possible to consider moving people from the City of Tucson to Mt. Lemmon in some form of mass conveyance. Because of the proximity to the metropolitan area and because of the recreational demands that can be satisfied on the mountain, this area would be worthy of further transportation related study and planning.

APPENDIX B

Potential Alternatives to the Private Automobile

APPENDIX B

Potential Alternatives to the Private Automobile

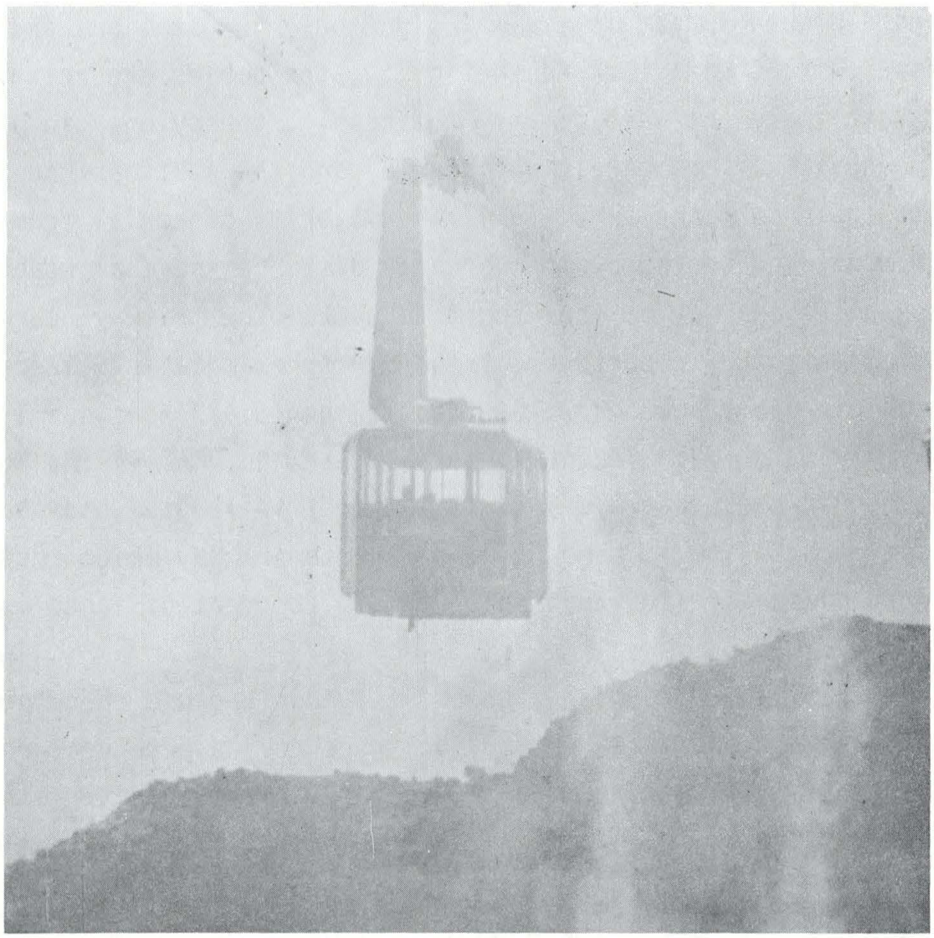
Aerial Tramways

An aerial tramway is a vehicle "that runs on a cable stretched through the air and that carries you in silent glory up and through the woods..." (91) Elements of this mode are the supporting cables, steel pylons, and two end stations. Ground impact is minimal since only the stations and pylons are in contact with the earth. Aesthetically, the cables are relatively small so that they are not particularly noticeable, the pylons can usually be placed so that they are barely noticeable, and the stations can be blended into their surroundsings. (91) The majority of aerial tramways are of the type mentioned above, but for greater distances several stages or separate installations may be used front to back. The tramway near Lake Maracible at Teleferico in northwest Vezuela, for example, utilized four stages to achieve a distance of 7.75 miles to the 16,427 foot summit of Pico Bolivar. (92) Mt. San Jacinto near Palm Springs, CA, is the location of the longest non-stop tramway, some 12,200 feet in length, which has a vertical rise of 5,873 feet. The Mt. San Jacinto tramway which cost $7,700,000 has two eighty-passenger cars that cover the 12,200 foot distance in eight minutes. (93)

European tramways are probably the most famous because there are so many of them. Alpine countries regard their scenery as a natural resource vital to the tourist industry and to the economy. In rugged terrain the tramway opens scenery up to anyone who can purchase a ticket, with little physical intrusion on the environment. The tramway from Chamoniz in France to Courmayeur in Italy, which goes over Mt. Blank, cost somewhat over $1,000,000 in 1956 for a horizontal distance of over 3 miles and a vertical distance of 12,500 feet. The route is over snowfields and glaciers where a more conventional transportation mode would have been very expensive, if not impossible to construct. (91)

Although there have been aerial tramways in the Eastern United States for several decades, the longest and more recent ones are found at the West Sandia Peak near Albuquerque, NM; (Illustration 37) Mt. San Jacinto near Palm Springs, CA; and Jackson Hole Ski Area in Teton Range, WY. (94, 93, 95, 96)

Figure 37
Sandia Crest Aerial Tramway



The aerial tramway as a transportation system offers unique possibilities. Although passenger cost per ride is fairly high, the aerial tram makes certain landscapes available to a viewer that he otherwise may not be physically capable of seeing.

Passengers are not in direct contact with the environment so operation impacts are practically non-existent. Because the passengers are a captive audience there are unlimited interpretation possibilities. Because of the fixed nature of the system, secondary impacts will be fairly high around the termination with limited impact along the link. Due to the nature of this type system,relocation of the terminal to allow impacted areas to recuperate would be highly impractical if not completely impossible.

Air Cushion Vehicle

The air-cushion vehicle (ACV) or hovercraft is a vehicle that could be best described as an air boat. The ACV "floats" over a cushion of air that it compresses in the area underneath the vehicle. The vehicle is flat bottomed with a flexible bag type skirt hanging from the vehicle's perimeter. Large fans force air downward through the skirt and flexible ducts force the air inward allowing the vehicle to float over a land or water surface while other fans propel the vehicle horizontally. The two major drawbacks to the ACV are the high level of noise produced and difficulty of steering at low speeds. (42)

The T4X ACV produced by Hovermarine Transport of Canada, was designed with five engines; three for propulsion and two to develop the air cushion. The 35 by 17.5 foot vehicle, costs about $200,000 and is capable of speeds of 50 kts. and 30 kts. over water and land respectively. (97) Another ACV, built by British Hovercraft is 130 by 78 feet and has the capability of moving 250 passengers and 30 cars at 80 mph. (42) Bell Aerospace of the United States has developed several ACV passenger models. The 21,000 pound Sk5 is 23 by 30 feet while the Sk9 weights 50,000 pounds and carries 210 passengers on its 32 by 55 foot surface. (98, 27)

The ability of these vehicles to go into remote areas was demonstrated by Smithers in 1968 when he took a 38 passenger British Hovercraft into previously unexplored areas of the Amazon. (99)

This type vehicle shows its greatest potential for use to be crossing water in areas where bridges are not feasible, and where shallow water prevents

conventional boats from taking shortest routes. One and a half million passengers and 250,000 vehicles (automobiles) have been ferried across the Dover Straits between England and France annually. (50)

Moving Belts

Moving belts or sidewalks have been introduced as long ago as the Columbina Exposition in 1893 and 1900 at the Paris Exhibition. Normally by these moving sidewalks are power-driven belts which slide over rollers similar to the more familiar conveyor belts. Safety is a major consideration of an evaluation of the moving belts. Passengers tend to become nervous while travelling long distances at relatively slow speeds. Variable speed walks and parallel walks attaining progressively higher speeds are areas where research has centered. The Good Year "Air Ride" has been recently installed at airports in Los Angeles and Montreal. The treadways move at speeds of 120 fpm carrying 7,000 people per hour. (100, 101) The Battelle Institute of Geneva, Switzerland, has proposed a modification of the moving belt for use at the Paris World Airport. The 7,000 passenger per hour system consists of six-foot-square platforms which move at 130 fpm. Doors at the front and rear of the platforms close to form a moving compartment which accelerates to 50 mph. (101)

Moving belts would appear to have limited potential for wildland application because their feasible uses would replace walking which is often a quite important element of the recreational experience.

Hydrofoil

The hydrofoil is the general name given to a boat which skims along the surface of the water on winglike structures attached to its hull. Total surface area of the boat that is in contact with water is decreased due to the lift produced at high speeds. This decreases drag and enables higher speeds than more conventional boats. There is limited potential for application of this mode in inland waterways because of the necessary docking facilities and the generally fixed routing used. (100)

Subways

A fully automatic subway system was installed in Montreal for Expo 67. This modern system was capable of moving some 30,000 people per hour over a 3.5 mile route consisting of two end terminals and three intermediate

stops. The distance was covered in 2.5 minutes. (102)

Mass conveyance systems which operate below grade would only have potential in highly developed areas where there exists some unique surface condition where actual passenger presence would not be desirable. During construction the unique condition would be disrupted so there is little potential for subway systems in wildland areas. One possible use for subway application in a wildland area would be for interpretation of natural sub-surface features or processes. In this case, a specially designed system would have to be developed for each particular application.

Tracked ACV

The tracked ACV is basically a train which uses an air cushion and horizontal and vertical guideways in place of wheels or conventional tracks. Prototypes of the tracked ACV have reached speeds of 400 mph at construction costs of less than one million dollars per mile. Track maintenance should be quite low because there is no direct contact between the train and its track. (42) There are several variations of the tracked ACV at present, both in type of track used and method of propulsion. The French Aerotrain rides on a reinforced concrete track resembling an inverted "T" and uses large turbofans for propulsion. The British Hovertrail straddles concrete box sections and uses an electric linear induction motor. (42) General Electric in the United States is constructing a model combining characteristics of both the Aerotrain and Hovertrail. This vehicle would use a linear induction motor and an air breathing turbofan. (103)

Another proposed tracked ACV, the Tri-Mono-Trans will be powered by a 5000 hp linear induction motor. At speeds less than 100 mph rubber tires support the train on the track; above this speed compulsion is used to create an air cushion for support. At the 300 mph or curising speed enough ram air enters the lifting fuselage to create the lift necessary to support the vehicle. At this point the compressors automatically shut off. This concept requires further testing before any conclusive evaluation of its potential can be made. (104)

High speed mass conveyance systems such as the tracked ACV have potential for solving wildland transportation problems only by their potential to physically link the metropolitan areas to the wildland areas.

Most wildland recreational areas are too limited in size to make high speed internal transportation attractive. From the recreational experience standpoint it is highly questionable if a high speed trip through a natural area would be in keeping with the concept of primitive recreation.

Tube Flight Trains

A tube flight train such as the one being studied by the Rensselaer Polytechnic Institute is basically a jet powered train operating in a large pipe or tube. Air is manipulated from the front and sides of the train to reduce air pressure built up in front of the moving train by means of the vortex concept. Cruising speeds of 300 to 400 mph can be obtained in runs of 25 to 250 miles. The system could easily be automated and would be "far more safe and dependable than any existing mode of transportation." (105)

Of the several designs existing for a tube flight train the "Gravity Vacuum Transit" system proposed by L.K. Edwards will be used for an example. This system has a capacity of 40 passengers and estimated construction costs of 88 thousand dollars for the actual vehicle and 5.5 to 20 million dollars per mile for the tube. (27)

Depending on construction impacts, this system has the potential for minimal environmental impact. One major drawback is that passenger visibility would be limited to the interior of the tube.

Buses

A partial listing of bus suppliers is given in Table 3 .

TABLE 3

Bus Suppliers (Partial Listing)

Ace Trailer
American Carrier Equipment Company

Fresno California
    Special Model - Double Deck Bus

Fortivan Commuter
Coach and Equipment Sales Corporation
P.O. Box 36
Penn Yan, NY 14527
    Specialty - Custom Van Conversion
    12-17 passenger

Continental Trailways
315 Continental Avenue
Dallas, TX 75207
    Specialty - Quality used buses
    Coaches

GMC Truck and Coach
Division of General Motors
Pontiac, MI
    Specialty - Wide range of models
    Custom work - turbine engine

AM General
American Motors Bus Division
Director of Marketing
AM General Corporation
Wayne, MI 48184

Custom Coach Corporation
1400 Dublin Road
Columbus, OH 43215
    Custom house

Electrobus, Inc.
12457 Ventura Blvd.
Studio City, CA 91604

Greater So. West Leasing Corp.
2715 So. Memorial Drive
Tulsa, OK 74129
    Bus leasing

APECO
APECO Transit Division
P.O. Box 668
White Pigeon, MI 49099
    Specialty - Midrange bus
    $12,000 to $16,000 range(1974)

PACE - Arrow
P.O. Box 101
1410 Millwood Road
McKinney, TX 75069
    Specialty - Motor home conversions

Mini Bus, Inc.
9301 Stewart and Gray Road
Downey, CA 90241
    Complete custom house

APPENDIX C

Selected Correspondence

CAMBRIDGE UNIVERSITY
Transport Research Project
6 Cavendish Avenue, Cambridge
CBI 4US

telephone 46005

20th July 74

Dear Mr. Jones,

thank you for your letter of July 11th – I enclose a copy of the brief report I wrote on the subject of recreation traffic in national parks and hope that it will be of some use to you. It concentrates more on the nature of the problem rather than on finding detailed solutions and so its interest for you may be limited.

I am now working on problems of traffic and transport in urban sociology and so I can give you no more detailed information on the question of traffic in national parks. I am however coming to the conclusion in my work on urban transport that the simpler the solution the better – and pedestrians and cyclists are best of all. It is perhaps a bit romantic to assume that everyone goes to a national park with the idea of escaping completely from civilization, but if they have to view the park through car windows or bus windows all the time, they're missing a lot.

yours sincerely,

Nicholas Pole

RECREATIONAL EQUIPMENT, INC.
P.O. Box 22088 • (206) 323-8333
Seattle, Washington 98122

July 17, 1974

Mr. Tom W. Jones III
Co-op #149-178
Graduate Research Assistant
Texas Tech University
College of Engineering
P.O. Box 4130
Lubbock, Texas 79409

Dear Mr. Jones:

In response to your recent letter, I'm afraid I will not be able to be of much help. We received only ten letters in response to our backcountry transportation proposal. Although all the letters were in favor of such a plan, we did not feel that this small a response warranted the great amount of planning necessary to impliment the plan.

I can forward suggestions about transportation made to us by our members, if you would be interested in that type of input.

Good luck with your study. Let me know if you are interested in the information I mentioned above and I would certainly be interested in hearing of some of the conclusions of your study.

Sincerely,

Sue Brockmann

Sue Brockmann
VIEW POINT

VOUGHT SYSTEMS DIVISION
LTV AEROSPACE CORPORATION

P O BOX 5907
DALLAS, TEXAS 75222

30 July 1974

Mr. Tom W. Jones, III
Graduate Research Assistant
Texas Tech University
College of Engineering
Department of Industrial Engineering
P. O. Box 4130
Lubbock, Texas 79409

Dear Mr. Jones:

Your letter of 11 July 1974 addressed to Mr. Paul Thayer has been forwarded to me for answer. The LTV Aerospace Corporation, Vought Systems Division, is pleased to supply the information that you request. Please find enclosed information regarding AIRTRANS and other related systems and a copy of the 1973 LTV Corporation Annual Report.

As you are probably aware, AIRTRANS has been operated under revenue service at the new Dallas/Fort Worth Airport since 13 January 1973. The vehicles have traveled more than one million revenue miles. AIRTRANS is a totally automatic transit system and because it is not subject to wage inflation is revenue producing. It is estimated that the system at the D/FW Airport will pay for itself in about fourteen years through the normal 25¢ per ride fares.

It is possible to build the AIRTRANS guideway at grade level, on an earth birm or on elevated sections. The cost of grade level construction is roughly one-third the cost of an elevated guideway. Also enclosed are artists' conceptions of automatic vehicles designed to accommodate wildlife recreation areas.

As more information regarding AIRTRANS becomes useful, please do not hesitate to contact me for assistance.

Sincerely,

R. L. Hueholt

sw
Encls.

BOEING AEROSPACE COMPANY
P.O. Box 3999
Seattle, Washington 98124

A Division of The Boeing Company

August 19, 1974
2-1710-1000-005

Tom W. Jones III
Graduate Research Assistant
Texas Tech University
College of Engineering
P.O. Box 4130
Lubbock, Texas 79409

Dear Mr. Jones:

We are enclosing background data describing the PRT Project at Morgantown West Virginia. We appreciate your interest in our Research & Development activity in Public Transit.

We have conducted some preliminary evaluations of feasibility of PRT in wilderness recreational areas, however, no conclusions have been made at this time. PRT is a relatively high capital cost investment which on a cash basis requires high utilization for pay out. Other, non fare, considerations such as environmental protection, crowd management and land use optimization are favorable to such an investment.

We will be pleased to provide further information as your research progresses.

Very truly yours,

John M. Dickinson

John M. Dickinson
Marketing Manager
Surface Transportation

JMD:bja
Encl.

Westinghouse Electric Corporation Industry & Defense Products

Transportation Center

Avenue A and West Street
East Pittsburgh Pennsylvania 15112

August 28, 1974

Mr. Tom W. Jones, III
Graduate Research Assistant
Texas Tech University
College of Engineering
P. O Box 4130
Lubbock, Texas 79409

Dear Mr. Jones:

Reference your letter of July 24 about mass transportation for wildlife areas.

Generally what the industry has been requesting for this type of application, is for very low speed with manual control and the guideway at ground level. The operator usually acts as a tour guide as well as operator of the vehicle or train. This gives him the flexibility of going slower and spending more time in areas of greatest interest.

Westinghouse does manufacture, install and maintain automatic mass transit equipment, however, this equipment is usually too sophisticated for application in wild life areas. Our present designs are for relatively high speed automatic control systems and does not lend itself to low speed manual operation. In addition, our system would be non-competitive in the area of cost because of the automatic control systems.

As you requested, we are enclosing several brochures that explain our Transit Expressway systems now in operation. Should you be interested in an automatic system to move a mass of people from point A to B, etc., we would be very interested in talking to you about your application.

Very truly yours,

D. J. Marsh

D. J. Marsh
Sr. Marketing Representative
Market Development & Services

DJM/nn
Enc.
cc: WTD Forest Hills - A. C. Sanderson
cc: WTD Forest Hills - P. R. Gillespie

National Railroad Passenger Corporation, 955 L'Enfant Plaza North, S.W., Washington, D.C. 20024 Telephone (202) 484-7100

Amtrak

July 30, 1974

Mr. Tom W. Jones III
Graduate Research Assistant
Texas Tech University
College of Engineering
P.O. Box 4130
Lubbock, TX 79409

Dear Mr. Jones:

We have your very interesting and farsighted letter on the subject of rail recreational passenger service, dated July 16, 1974. The whole concept is right and it is one of those things which rail travel has the potential to do better than any other. However, the realistic attainment of such a goal must remain for the future....and I regret to add, that it must be in the far-out future.

The present pattern of rail travel in this country is quite static. By that I mean, Congress has prescribed the "end-point" cities which we must serve and that means that the routes we serve are fixed, e.g. Chicago-Los Angeles. This also means that there are a lot of places which we do not serve, Lubbock for one, and which we shall not be able to serve for some time to come.

The next basic factor is that we are equipment poor. We do not have cars and trains sitting in yards waiting for some move to come along. We own some 2030 cars and save for those in maintenance of one kind or another, they are all in use every day. In fact, on certain peak days, on busy routes, we have run out of cars and passengers have had to stand or have been passed up. These are the unfortunate facts of life.

Having said this, I must hasten to add that it will not always be so. We have now on order hundreds of millions of dollars worth of cars and locomotives. With their delivery, in 1976 and thereafter, we hope to strengthen our present system and get rid of many of these old cars which we have. Then gradually, we shall rebuild and expand our fleet.

Looking ahead, Congress requires that we open one new "experimental" route each year. This year the Boston-Chicago route has been designated by the Secretary of Transportation as the new route. We are working on that now.

So you see, somewhere in the years ahead we hope to create the ability and the resources to be able to respond to requests such as yours. We believe in the same things you are saying, only we know our present shortcomings.

I have in a sense answered your last question, "L" first. If it is not now feasible, there is not much sense in answering the other questions. Let me cite one example: If the track from Lubbock to Leadville has not been used for years, it might take us 12 to 18 months to re-open it for passenger service (track design for passenger service is different than for freight service).

We wish to thank you for your interest and for your very good ideas. We hope that the days when this can be done are not too far away. They are as far away as the American public wants them to be. Our greatest support to date has come from Congress.

Very sincerely yours,

L. Fletcher Prouty

L. Fletcher Prouty
Director, Plans & Projects
Public Relations

LFP/gnf

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REFERENCES

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